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## Editorial

### THE PRESENT STATUS OF THE SURGICAL TREATMENT OF ACUTE CHOLECYSTITIS

A STUDENT of this particular subject in the realm of surgery must be amazed with the divergence of opinion which prevails in the surgical treatment of acute cholecystitis. The controversy continues between the advocates of the "immediate" and the "delayed" type of therapy, with each group having its staunch supporters.

The clinical reports advanced by both groups are of a striking variation and it behooves one to reflect why this difference of opinion should exist.

In delving further into the subject one is astonished with the laxness of terminology applied and the definitions accepted. To one, "immediate" surgery may mean immediately after the onset of the disease; and to another it may mean immediately after admittance to the hospital. The term "early" is subject to wide interpretation with a resulting lack of unity of definition. The third term usually applied to stages in which surgery is or is not to be performed is "delayed." This term is also subject to such wide and varied meaning that only confusion results in the interpretation of any of the three terms.

As we leave the question of time of operation we are confronted with another problem which must receive serious consideration, and that is the marked discrep-

ancy between the surgeon's postoperative diagnosis and the pathologist's report. One cannot help but conclude that the tendency of the surgeon is to magnify the pathological state found which in some instances is so marked that one wonders if the same specimen is being described by both the surgeon and the pathologist. While we concede that there may be a difference of opinion between pathologists, we, however, are of the opinion that the pathological report must be accepted as the court of last appeal.

Fortunately, practically all surgeons are agreed on this point—the pathologist's report is necessary to establish a correct and final diagnosis. Knowing the marked difference of opinion which frequently exists between the surgeon and the pathologist, and the fact that the clinical findings are very frequently not in accord with the pathological findings, one is amazed with the number of reports published on clinical findings and gross description of the pathological condition, entirely ignoring the pathological report if available.

Within the past few years the high percentage of gangrenous gallbladders encountered by some surgeons and the low percentage encountered by others should cause us to stop and think. Why should

reports from the same section of the country show such marked variations?

In studying the "follow-up" of patients with gallbladder disorders in private hospitals one encounters great difficulty in being able to secure an unbiased opinion. Certainly with all the standardization and detail necessitated in keeping clinical records at a private hospital, ways and means should be devised through which an open and free expression of the patients' end results could be obtained. In order to obtain a proper evaluation of the end results, not only must we use the large individual series and the series obtained at our charity and semicharity institutions, but also, those from the private institution where, as a rule, the surgical staff is not controlled as well as at a public institution.

Certainly the integrity and sincerity of the surgeons doing clinical research in this field cannot be doubted; but why all this marked conflict of opinion? Could it possibly be due to the large number of variable and uncontrollable factors which confront the clinical research fellow? Or could the individual surgeon be talking of a slightly different phase of the same pathological process?

So until certain basic principles are prescribed for reporting clinical research, and, until the clinical research student is more specific in his reports, then, and only then, will we leave this Babelian haze and emerge with a bigger and better understanding of the problems confronting us.

C. A. BACHHUBER, M.D.

## CORRECTION

THE following letter received from the Office of the Surgeon General and written by Major General Norman T. Kirk, of the U. S. Army, was received by the Editor:

"In the editorial 'War Organization of Plastic Surgery' by Jacques W. Maliniac, in the September, 1943, issue of *The American Journal of Surgery*, it is stated that the pleas of the plastic surgeons, including those of the writer, to establish a Division of Plastic Surgery in the Army for the casualties requiring plastic repair have been met 'so far without success.' It is further stated that 'sooner or later the indicated reforms will probably come,' but that 'time is running short.' The unfortunate implications of these statements and the reprovable reflection of the entire editorial that the Army has not recognized the importance of or made efforts to provide adequate facilities for the care of patients requiring plastic surgery are absolutely unfounded and unjustifiably animadversional.

"Had Dr. Maliniac made even the same effort in determining the real facts as in blithely preparing this captious editorial, he would have learned that the Medical Department of the Army had many months ago inaugurated a most carefully planned program for the care of these patients. There have been estab-

lished in general hospitals in this country five centers for plastic and reconstructive surgery, each of which is staffed by competent and well recognized plastic and oral surgeons. These centers are also provided with all the modern facilities and specially trained personnel necessary for the proper performance of this highly specialized work including sculptors, artists, photographers, and occupational therapists. All plastic reconstructive surgery in the Army is performed at these centers. In addition to these facilities, careful consideration has been given to the early management of the wounded who will ultimately require reconstructive surgery. Accordingly, special plastic and maxillofacial teams staffed with well qualified personnel have been formed and provided in the most forward hospital installations in the Overseas Theaters. That the Army thoroughly recognized the significance of initial treatment of these casualties is shown by the fact that a training program has been established with courses, conducted by leading plastic surgeons in University Medical Centers, designed to teach basic principles of plastic surgery to medical officers who will be assigned to the forward hospital installations."

T. S. W.

# Original Articles

## CRANIOCEREBRAL WOUNDS\*

### EXTERIORIZATION METHOD OF TREATMENT

JEFFERSON BROWDER, M.D.

BROOKLYN, NEW YORK

THE surgical principles exercised in the treatment of recently sustained open wounds of the brain are not dissimilar to those underlying the treatment of fresh wounds encountered elsewhere in the body, namely, careful débridement, complete hemostasis and primary closure of the wound. The appropriate use of the sulfa drugs, both locally and systemically, has in nowise altered these fundamental principles. Prior to the sulfa era it was quite generally agreed that all wounds, especially compound fractures, should be débrided as soon after injury as feasible, this being governed somewhat by the state of shock prevailing in any given case. Evidence is slowly accumulating which suggests that following the use of sulfonamides, open wounds of the skull and cerebral cortex may be débrided and closed as late as thirty-six to forty-eight hours after injury with reasonable expectation of primary healing and without late intracranial complications.

According to the report of Professor Lebedenko,<sup>1</sup> the Russian surgeons in the present war have extended the period of operability with primary closure of this type of wound up to two weeks with satisfactory healing. This is a radical departure from tradition. During the last war, and in civil practice for the past twenty-five years, open wounds of the cerebral cortex which for one reason or another did not receive definitive treat-

ment for one day or longer following injury were not closed and the area of involved brain was permitted to herniate. For several years I have been applying a method for neglected wounds patterned somewhat after the plan of exteriorization of brain abscess as recommended by King.\*<sup>2</sup> Inasmuch as there is not complete agreement of opinion regarding the technical steps that are held as requisite in the management of patients with wounds of this type, it seems permissible to present in some detail this operative technic and method of postoperative dressing which, it seems to me, merits wider utilization. The method is also applicable to an open wound of the forehead implicating the frontal and/or ethmoidal air sinuses with or without an open wound of the brain. Lesions resulting from penetrating missiles that have traversed both cerebral hemispheres are infrequently encountered in civil practice, consequently my experience does not warrant consideration of these.

#### DELAYED TREATMENT OF OPEN WOUNDS OF THE BRAIN

The circumstances that seem to permit undue delay in the treatment of patients with this type of lesion are various. The commonest of these in civil practice is the instance in which a severe craniocerebral

\* According to this publication the brain was permitted to herniate. In recent years herniation has been prevented.

\* From the Neurosurgical Service of the Kings County Hospital and the Neurological Unit of the Brooklyn Hospital.

trauma has been sustained and the patient is admitted to the nearest hospital. The scalp is found to be lacerated, the underlying skull obviously comminuted and depressed and blood admixed with brain tissue is matted in the hair. The face is pallid, the extremities sweaty and cold, the pulse small and moderately accelerated, and the systolic blood pressure, if obtainable, is very low. Those in attendance estimate that death is imminent, consequently few if any, therapeutic measures are instituted. Untreated, some progress unfavorably and die within a few hours, however, others so injured hold on with surprising tenacity. In due course the skin becomes warm, the systolic blood pressure increases slightly, the pulse is slower and there are purposeless motor responses to painful stimuli. Fluids are given parenterally but the patient remains about the same and is still considered "in no condition for major surgery." After a relatively stationary level of vital signs for forty-eight to seventy-two hours, it is finally decided that since he is not going to die, possibly something could be done for him. When examined at this period, physical and cytological evidence of early meningitis may be present. Inspection within the local wound usually discloses autolysis of detached brain and blood clots suggesting well established infection.

As stated, it has been common practice to débride all such wounds as well as possible, cover the exposed area with gutta-percha or a material of comparable texture and permit the damaged brain to herniate through the cranial opening. This invariably results in the so-called fungus-cerebri, a most undesirable complication and a situation difficult to manage successfully. Far too frequently that part of the fungus adjacent to the bony margin undergoes pressure necrosis at some point, thereby permitting bacterial invasion with resultant brain abscess, meningitis, or both. Patients treated in this manner who survive pass through a long period of convalescence before the wound finally heals.

Measures may be instituted to prevent the formation of fungus cerebri in all patients receiving definitive treatment forty-eight hours or longer after injury. Systemic sulfonamide therapy is mandatory. With the patient lying either on his side or abdomen upon the operating table, the scalp should be carefully dry shaved, each stroke of the razor being away from the wound. After appropriately cleaning the area with antiseptics, a field block of the operative area is performed with 0.5 per cent novocain. A spinal needle is inserted into the lumbar thecal sac for withdrawal of cerebrospinal fluid when necessary. Sterile drapes are put in place. Scalp flaps are cut or the already present lacerations are extended in order to expose adequately the bony defect. The scalp, bone, dura and brain are débrided, taking particular care to remove all softened cerebral tissue by suction, hemostasis being secured by applying the electro-coagulating current to the metal tube of the sucker whenever a blood vessel is drawn into it. The dura should be cut away to the limits of the cerebral defect. After débriding the wound, or in some instances while removing the necrotic brain, cerebrospinal fluid should be withdrawn through the spinal needle in order to reduce the possibility of cerebral herniation. At the termination of the cleaning-up process, a sufficient amount of spinal fluid should be drained away to obviate any tendency for the wall of the cerebral cavity to fold on itself. However, excessive quantities of fluid should never be withdrawn since this may cause the intact pia-arachnoidal surface at the margin of the wound to fall away from the undersurface of the dura, thus opening the subdural space. After the cerebral cavity has been opened widely, the entire area is covered with a single layer handkerchief of mesh gauze (44 by 40 per square inch). The gauze should be gently pressed against the wall of the entire operative defect in order to "iron out" any small area of the gauze that has not come in complete

apposition with brain. Sulfanilamide crystals are then blown on to the handkerchief lining the cavity. (Fig. 1.) The cavity is

herchief of gauze is moistened with salt solution and slowly removed, care being taken in separating the pack from the

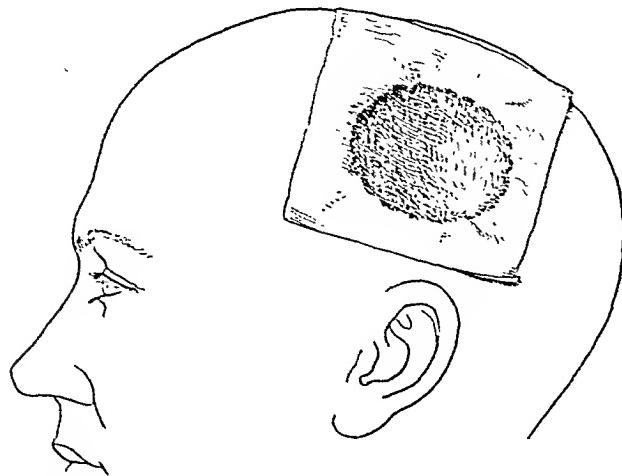


FIG. 1. Gauze handkerchief lining débrided cavity of brain.

then packed with one-half inch gauze strips (Fig. 2) to the level of the scalp. The flaps of scalp are brought over the area and loosely approximated with sutures. (Fig. 3.) A snug-fitting dressing composed of wet, flat gauze held firmly in place by a skull cap made with wet surgical three-inch bandage should be applied to prevent herniation.

During the postoperative course, the effects of increased intracranial tension may be favorably altered by withdrawal of cerebrospinal fluid through the lumbar area. Occasionally, it becomes necessary to perform spinal punctures every three or four hours for two or three days. In some instances the increased tension may become too excessive to be handled in this manner. If this occurs, the wound should be reopened. For this procedure the patient is placed on a side and 20 to 30 cc. of cerebrospinal fluid slowly withdrawn by lumbar puncture and the needle left in place. The external dressing of the head is then removed and the scalp suture cut. If there is a tendency for even slight protrusion of the intracranial pack upon releasing the flaps of scalp, an additional amount of fluid is withdrawn through the spinal needle. The pack within the hand-

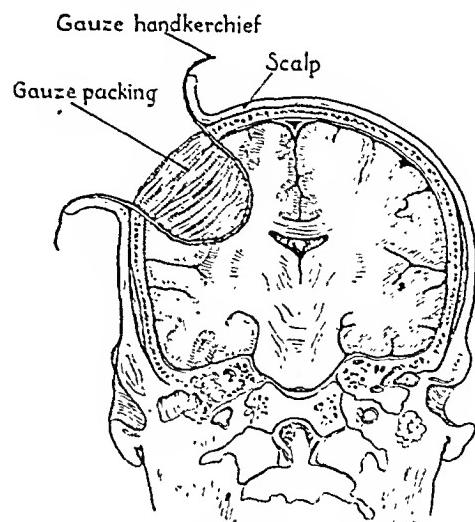


FIG. 2. Cross section of brain showing gauze handkerchief in place and cavity packed with narrow strips of gauze in order to prevent brain from herniating through cranial opening. Packing should extend to level of outer table of skull as illustrated.

handkerchief. The cavity is repacked loosely, scalp flaps resutured and a snug moist dressing reapplied.

Occasionally, the first postoperative days present almost insurmountable problems.

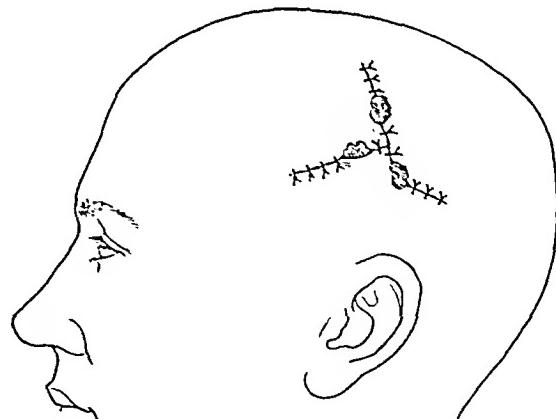


FIG. 3. Scalp wound loosely approximated with tufts of gauze packing drawn through the incisions to permit drainage of superficial part of wound.

Meningitis may complicate the issue, thereby making the control of intracranial pressure particularly difficult. Seldom, however, will brain abscess develop if the wound has been properly débrided. The

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most serious and usually fatal complication is spontaneous opening of a lateral ventricle into the wound. This results from



FIG. 4. Photograph of patient with cerebral fungus following pinch grafting. Several small areas of incomplete epithelialization may be seen.

advancing necrosis of cerebral tissue with implication of the ventricular wall which frequently tends to outpouch toward the cranial defect. Thus far treatment of this complication has been unsuccessful.

Provided all goes well and no noteworthy complications arise, wounds managed as described are not dressed for three to five days following operation. For dressing, the patient is placed on his side, cerebrospinal fluid withdrawn from the lumbar thecal sac, the wound reopened and the gauze pack removed as previously described. The cavity lined with the adherent gauze handkerchief is filled with full strength hydrogen peroxide and washed out with saline. This should be repeated three or four times before attempting the loosening of the handkerchief. The removal of the lining gauze at the first dressing is a slow and tedious procedure. It can be safely accomplished only by irrigating and painstakingly dissecting the gauze from the adherent soft brain with small cotton

pledgets. Tension on the gauze is to be strictly avoided. After the entire wound has been made dry of fluids, a fresh handkerchief is applied to the wall of the cavity and gently pressed with cotton so that it is in complete apposition to all exposed surfaces. The gauze is then covered with a layer of sulfonamide crystals. As before, the cavity is packed with one-half inch gauze strips up to the level of the scalp. The entire bony opening must be filled with the pack in order to prevent a knuckle of brain tissue from herniating. The flaps of scalp are replaced over the pack and held in position by an untied continuous suture of the galea. The same type of "wet" head dressing is applied. Control of excessive intracranial tension by means of lumbar puncture is to be continued if indicated. The wound should be dressed in this manner about every third day. After the second or third dressing, resuturing of the flaps of scalp is not feasible since these flaps tend to retract somewhat and become sufficiently rigid to be held in place by a closely applied head dressing.

Each dressing becomes less arduous. In about ten to twelve days the entire cavity is covered with granulation tissue, the surface of which must not be injured during dressings. Such an accident opens up an avenue for infection with possible abscess formation. Should this complication arise, the abscess is opened into the cerebral cavity and the entire defect lined with the gauze handkerchief. Slowly the cerebral wound becomes smaller and finally, by gradually decreasing the amount of intracranial packing, the granulating surface rises to the level of the cranial vault. After epithelialization becomes complete, plastic repair of the scalp and cranial defect may be carried out at a later date.

Although fungus cerebri can and should be prevented, one occasionally encounters a patient in whom this condition is already established. By withdrawal of 20 to 30 cc. of cerebrospinal fluid from the lumbar thecal sac, two or three times in twenty-four hours, the protruding mass usually

recedes somewhat and thereby releases the pressure of the hernia against the firm margin of the cranial opening. Just as soon as the surface of the fungus is covered with sufficient granulation tissue to support epithelization, pinch grafting of skin should be carried out. (Fig. 4.) Within two to three months after complete epithelialization has occurred the entire area may be excised, the cranial defect filled with a plastic material and whole thickness scalp flaps fashioned and shifted to cover the involved area.

#### COMPOUND FRACTURES THROUGH THE NASAL ACCESSORY SINUSES

It is quite generally agreed that the most important step in the management of a compound fracture of the skull implicating the frontal sinus, dura and anterior aspect of the frontal lobe of the brain consists of débridement of the brain and closure of the dura. It is frequently stated that if necessary, the dural opening should be closed with a transplant of fascia. The details of the subsequent steps in the operative procedure have, however, not been stressed. What disposition should be made of the frontal air cell or cells? Should the scalp wound be closed or drained? If drained, what type of drainage is to be used?

Frequently, the fracture extends along the floor of the anterior cranial fossa opening the ethmoidal air cells as well. In most instances the rent in the dura cannot be repaired with a fascial transplant; and whenever this is carried out, the transplant may slough away, especially if infection of the area supervenes. Moreover, closure of the wound of the forehead after débridement of the skull and frontal air sinus is not a complete closure since the infundibulum is open and as stated, the ethmoidal cells are frequently implicated. Such a procedure only invites suppuration. Therefore, all open wounds of the forehead implicating the accessory air cells with or without laceration of the dura and brain have been treated in the following manner. The position of the patient on the operating

table, preparation of the scalp, introduction of the spinal needle into the lumbar thecal sac and exposure of the implicated

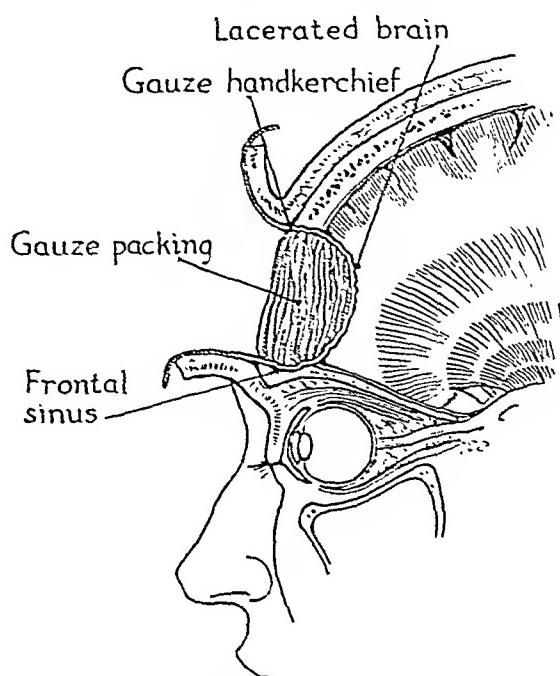


FIG. 5. Illustrating method of treatment of compound fractures of the skull implicating frontal sinuses, dura and brain. If the ethmoidal air cells are involved, an additional strip of gauze should be placed in the epidural space along the mesial roof of the orbit on the side of the fracture.

area are the same as described for wounds of the cranial vault. The margins of the skin are cleaned, both anterior and posterior walls of the involved frontal sinus removed, leaving a margin of bone for a supra-orbital ridge, the remaining lining membrane of the sinus dissected away and the bony surface from which it was removed curetted and carbolized, the edges of the torn dura cut away, all macerated brain removed, complete hemostasis secured, the dura closed tightly if possible, and the extradural space lined with a handkerchief of gauze and the cavity packed. (Fig. 5.) If the dura cannot be closed or if the operation is performed twenty-four hours or later after injury, the dura is opened the full extent of the brain lesion and the entire area marsupialized. Subsequent dressings of the wound of the frontal area are carried out as for the lesions of the cranial vault.

## COMMENT

To my knowledge there is no simple term that adequately differentiates the compound fracture of the skull associated with tearing of the dura and maceration of the cortex of the brain, from the compound fracture (be it comminuted and/or depressed) without puncture of the dura. That there is a vast difference in these two lesions is quite generally accepted. In truth, even the crudest sort of operative procedure carried out on patients with compound fractures of the vault without dural implication usually results in satisfactory healing. Experience has shown that with an intact dura, comminuted and detached fragments of skull may be replaced in a contaminated wound that has been carefully débrided and primary healing of the bone results. The decision regarding the sacrifice of bone quite naturally depends on the estimated degree of contamination. On the other hand, the open wound of the brain and compound fractures through the frontal sinuses with or without open wounds of the brain, present an entirely different problem. The potential complications that may arise from any one of these make it desirable to operate within a period of six to eight hours following injury. Shock should no longer be a troublesome factor. With our present therapeutic armamentarium, any degree of vasomotor collapse can be corrected within a few hours and supportive measures continued throughout the operation and as much of the postoperative period as indicated. I can see no advantage in waiting longer than this arbitrary time although in exceptional instances of multiple injuries, postponement of the cranial operation may be advantageous.

If for any reason operation has been deferred for a period longer than forty-eight hours after injury, the methods outlined are by far the safest procedures

to follow. They are the hard way, the most tedious and time-consuming, however, amply rewarding the surgeon for his untiring efforts. Short cuts have been tried but most of these have been found wanting. The traditional teaching that gauze should not come directly in contact with the brain has led to the use of gutta-percha or a similar material for the handkerchief. Many substances have been tried but no substitute for 44 by 40 mesh gauze has as yet been found. Coarser mesh gauze permits granulation to grow through the fenestra whereas finer mesh material will not "stick" to the wall of the cavity.

The failure to insert a spinal needle into the lumbar thecal sac in order to control the degree of herniation of the brain, both during the original operative procedure and subsequent dressings, has led to unnecessary complications. Without the reduction of intracranial pressure, particularly during the dressing, the wall of the cavity tends to fold on itself thereby creating a situation favorable to abscess formation. Furthermore, there seems to be considerable reluctance on the part of some to believe that frequent spinal puncture with drainage of cerebrospinal fluid is an advisable procedure for the control of elevated intracranial tension. It is fraught with some danger; however, it still stands as the most reliable method of reducing pressure in the patients with compound lesions of the head treated as described.

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# POST-TRAUMATIC PSYCHOSIS IN THE AGED\*

## TREATMENT WITH SEX HORMONES

H. D. COGSWELL, M.D.  
WHITING, INDIANA

AND

S. C. DAVIS, M.D.  
TUCSON, ARIZONA

THE study of geriatrics has been neglected and as a consequence the process of aging is poorly understood. Many senile individuals have died and are now dying due to our lack of knowledge regarding the physiology of the aged. It is not infrequent that a senile individual, after some form of trauma often trivial, is placed in bed to recover, but instead breaks down mentally or physically and dies. There is a dearth of information regarding this condition in the literature, yet any physician in active practice will see several cases a year following just such a course.

When these patients have been confined to bed for a varying period of time they may become restless, disoriented as to time and place, or they may become lethargic to the point of coma. The mental powers usually show impairment. Irritability and insomnia are common and anorexia is present. The course is usually unfavorable, ending in a terminal pneumonia or, in some instances, these people die without any discernible cause. Many of these patients appear to be in excellent condition up to the time of their injury. It is generally believed that getting these people out of bed as soon as possible and allowing them to exercise is of value in preventing this syndrome. In many cases this cannot be allowed due to the nature of the patient's injury.

In the past few years three patients have been observed who evidenced such symptoms following injury in which empiric medication seemed successful. For this reason and for the purpose of stimulating further observations as to its worth, a preliminary report seemed justified.

### CASE REPORTS

CASE I. Mrs. J. R., a white female, age sixty-six, entered the hospital on October 9, 1940, following an automobile accident. She had been unconscious for a short period of time following the accident, but when examined in the admitting room of the hospital was rational and well oriented. Her past history was negative for mental symptoms. The pertinent physical findings were: Tenderness over the sternum and midportion of the dorsal spine, some evidence of kyphosis in the region of the fifth dorsal vertebra and a laceration about 5 cm. in length on the lateral aspect of the right knee which was bleeding profusely. The blood pressure was 140/80.

The laboratory findings were: red blood cells, 4,340,000; hemoglobin 13.0 gm., white blood cells 12,050, the urine was normal and Kahn and Kline tests were negative.

X-ray films of the spine showed a compression fracture of the fourth, fifth and sixth dorsal vertebrae.

The patient was placed on a "hard" bed after the laceration had been sutured and her condition appeared satisfactory. Marked abdominal distention developed the day after admission which persisted about four days subsiding on conservative treatment. On October 24th, definite signs of a bronchopneumonia were found and sulfapyradine was started in moderate amounts. The patient's mental capacity was normal and continued to be normal until about November 3rd. At this time it was noticed that her memory was very poor and that she did not recognize some of the nurses who had been attending her since the time of her admission to the hospital. She became quite disagreeable and hard to manage. The mental confusion progressed and her physical condition became worse although x-ray studies and physical signs indicated that the pneumonic process was healing.

\* From the Whiting Clinic, Whiting, Indiana.

During this time her daily temperatures ranged between 99.8 and 101.6° F. It was believed that the sulfaypyradine was responsible for the mental and physical deterioration and was discontinued on November 11th. The patient's temperature subsided to almost normal several days after the withdrawal of the drug but no improvement was noted in her mental condition.

Laboratory studies on November 12th were as follows: red blood cells 3,680,000; white blood cells 7,850; hemoglobin 12.0 gm., urine negative, total nonprotein nitrogen 24.4 mg. per 100 cc., and the creatinine 2. mg. per 100 cc.

There was no improvement in the patient's mental status in the next few weeks, and a progress note written on November 29th reads, "Mental confusion worse. Sometimes recognizes people but thinks she is living in California. Constantly attempts to get out of bed and talks incessantly without point. Condition poor." On this date 5,000 units of estrogenic substance (Theelin) was given intramuscularly. This was repeated every day until December 11th. Improvement in the patient's mental state was apparent by December 3rd and a progress note written on December 10th states, "Entirely clear mentally, feels good, has no complaints." The patient was discharged from the hospital on December 12th wearing a Taylor back brace and has remained normal since the time of discharge.

CASE II. E. R., a white male, age sixty-five, entered the hospital on November 27, 1940, following an automobile accident. The patient had had an auricular fibrillation for two to three years and bronchopneumonia one year previous to this hospital admission. There had been no recent signs of cardiac decompensation and his general condition had been good during the past year until the time of the accident.

Physical examination was negative except for abrasions and tenderness over both lower extremities and midlumbar area, auricular fibrillation with cardiac enlargement, a blood pressure of 180/110 and some abdominal tenderness over the right costal area.

Laboratory findings were: red blood cells 4,930,000; white blood cells 7,850; hemoglobin 14.0; urine negative; Kahn and Wassermann

tests negative. X-ray films revealed a compression fracture of the second lumbar vertebra.

The patient was placed on a "hard" bed and given sedation and digitalis. A progress note on November 29th reads, "Consultation requested on account of symptoms apparently secondary to injury. One of the outstanding symptoms is mental confusion. Conversation not intelligible and memory very poor. Does not remember seeing nurse that served breakfast. Examination shows fibrillation of heart, rales at base of lungs, and distention of abdomen."

The patient was seen on this date and the administration of testosterone propionate was suggested. Twenty-five mg. of this drug was given the following day and repeated at three-day intervals, the last dose being administered on December 10th. With the exception of sedation and digitalis which had been given daily, the testosterone propionate was the only other medication given. Mental improvement was noted by December 2nd and the patient's mental state seemed normal by December 12th. He was fitted with a Taylor back brace and was discharged from the hospital on March 18, 1941, mentally clear and ambulatory.

CASE III. Mrs. C. F., a white female, age seventy-three, was admitted to the hospital on March 14, 1942. She had tripped and fallen in her home about two hours before admission and was unable to walk due to pain following the accident. She had been known to have diabetes mellitus for two years and was taking 25 units of protamine insulin daily which controlled the diabetes. In 1939, the patient had had a "stroke" with a transient paralysis of the left extremities. During the past five years her daughter, with whom she lived, had observed that the patient had been childish, forgetful and fretful.

The positive physical findings were: Arcus senilis of both eyes, motor weakness of the left leg and arm, bilaterally hyperactive knee jerks, a positive Babinski of the left foot, tenderness over the entire lumbar spine, and a blood pressure of 150/100.

The laboratory findings were: Red blood cells 3,500,000; white blood cells 12,100; hemoglobin 64 per cent, urine 2 plus sugar, 2 plus albumin and gross blood.

X-ray studies demonstrated a compression fracture of the first and second lumbar verte-

brae with a fracture of the lower ramus of the pubis on the right side.

The patient was placed on a "hard" bed and given carbon dioxide inhalations every four hours to aerate the lungs. During the first few days in the hospital the patient required catheterization and grossly bloody urine was obtained. This gradually cleared so that by March 19th the urine was free from red cells microscopically. The patient complained a good deal and was unco-operative but her general condition remained fairly good until the evening of March 20th. At this time the patient tried to get up and defecated in bed. She was restless and talked incoherently. No medication had been given to account for this behavior. Her condition had not improved by the next morning and she thought that the intern was a member of her family and begged him to "take her away from the river." In the next few days she became quieter and it became difficult to arouse her. There was no diminution in her motor powers or changes in her reflexes indicating another cerebral accident and a non-protein nitrogen test was normal, excluding uremia as a cause of the comatose condition. She had ceased eating and her water balance was maintained by intravenous infusions. A blood sugar on March 23rd was 134. On that day 5,000 units of Thelin was ordered. By mistake this dose was given twice on the same day so that the patient received 10,000 units. Two days later the patient was more alert and her physical condition seemed slightly improved. Her progress from this time on was satisfactory and Thelin was continued in doses varying from 2,000 to 5,000 every three days until her discharge from the hospital on April 9th. At this time the patient still showed the signs of senility that were present at the time of her admission to the hospital, i.e., obstinacy, stubbornness and forgetfulness but she was much improved over her state several weeks previous to her discharge.

It is interesting to theorize as to why this syndrome occurs. Detailed laboratory studies might give more definite evidence as to the cause of this condition but unfortunately this was not done in any of the above cases. Sex hormones were given to these patients, because this complication was not seen in younger individuals under similar conditions. Since these hormones

are known to be diminished after the climacteric it was hoped that their replacement might aid therapeutically. Three cases are not enough from which to draw any definite conclusions, but the results have been gratifying enough to warrant further investigation and trial. It was noted that there was a close similarity in the behavior of these patients and that of a younger group with a sublethal anoxia. With the sclerotic, thickened walls of the blood vessels found in senile brains, there is ample reason for the existence of a borderline anoxia of the cerebral tissue. Vasospasm initiated by trauma may be the factor in producing a brain ischemia. Herrmann and McGrath<sup>1</sup> administered estrogen to patients exhibiting vasospasm in the extremities and noted marked improvement in most of their cases. It has been likewise shown that the male hormone improves the peripheral circulation in Buerger's disease and arteriosclerosis.<sup>2</sup>

From these observations it may be inferred that the sex hormones have an important part in maintaining vasomotor stability and may explain their beneficial action in the above patients. Symptoms of anoxia are more easily produced in the older than in the younger person as there is a narrow margin between ample cerebral oxygenation and anoxia in the aged. Oxygen was not administered to any of these patients as the possibility of cerebral anoxia was not considered at the time. Although oxygen therapy should be tried in these cases, it is questionable that it would be of benefit. Lindquist and LeRoy<sup>3</sup> have recently shown that the administration of 100 per cent oxygen to animals with head injury had no appreciable effect in increasing the cerebral oxygen consumption. They believe that "vasomotor mechanisms are of much more importance in the early symptoms of head injury than brain edema or increased intracranial pressure." This adds further weight to the hypothesis that, in the above described cases, vasospasm was the motivating factor.

It is known that the sex hormones, working either independently or in association with the other hormones, have a variety of functions. If these patients recovered as a result of their hormone therapy, there are other actions of these endocrines which must also be considered to account for the benefit received. The sex hormones are known to act as a control on the pituitary gland and in turn they influence the thyroid, adrenal and other ductless glands. Many of these actions are complex and poorly understood. If it can be established that the described treatment is of value in these elderly cases it will be illuminating to know why it is of benefit.

#### SUMMARY

Three senile patients who showed typical mental symptoms following injuries which confined them to bed were treated empirically with the sex hormones and recovered. It is urged that similar patients be treated in this manner to determine the value of this treatment and that the results be reported.

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As a rule, hygromas do not require immediate operation, if the diagnosis can be definitely made. However, any persistent focal symptoms call for exploration of the side involved as soon as uncertainty can be dispelled. Persistent high intracranial pressure should be subjected to exploration and, when closing the wound, a skull defect should be left beneath the temporal muscle to permit decompression.

From "A Manual of the Treatment of Fractures" by John A. Caldwell (Charles C. Thomas).

# PENTOTHAL SODIUM IN MAJOR SURGICAL PROCEDURES

JULIUS D. HOLLY, M.D.

Associate in Anesthesia, Sinai Hospital

BALTIMORE, MARYLAND

IT has always been my desire some day to be able to administer an anesthetic that would produce rapid induction, quiet breathing, normal color, no salivary secretion, surgical relaxation, a maximum of safety and rapid elimination; an anesthetic that did not alter the function of organs, and one in which recovery occurred without nausea or vomiting. From practical experience I believe that to date there is such an anesthetic in intravenous pentothal sodium. Its action resembles the principles of an "ideal anesthetic," and its development marks a great advance in anesthesia.

Intravenous anesthesia is not a new procedure. In 1872, Ore administered chloral hydrate intravenously; in 1905, hedonal was used in the same manner; Bardet, in 1920, used somnifene; Fredet, in 1920, used numal but was unable to obtain complete anesthesia; in 1925, ipral was used; pernoston in 1927; in 1929, barbiturates were first used intravenously to induce anesthesia. Sodium amytal was the first to be employed. In 1932, evipal was being used extensively in this country being imported from England under the name of evipan. Incidentally, the author was one of the first in Baltimore to administer evipan, the patient being a man 102 years old who had a three-stage prostatectomy. He required only 1½ cc. for complete anesthesia. Most of the intravenous anesthetic agents produced marked respiratory paralysis and not complete anesthesia, and were thus gradually discarded until the advent of evipal and pentothal.

In the selection of an intravenous anesthesia there are three very important considerations: (1) The quantity of anesthetic required to produce the desired anesthetic effect; this is called the minimal effective dose. (2) The relation of that dose

to the amount that will produce death; this is called the minimum lethal dose, and the ratio between the two is called the "safety ratio." (3) To be controllable the drug must be rapidly destroyed or eliminated. The smaller the minimal effective dose, the larger the safety ratio, the more valuable is the drug.

Chemically, barbiturates are produced by condensing a simple or substituted mallonic ester with a urea. The basic substances required are the various alcohols. Pentothal is a barbiturate in which the oxygen is replaced by sulfur and is the sodium salt of this compound. Neonal and amytol are slowly eliminated; nembutal and pentothal are rapidly eliminated.

As we are fully aware of the action of inhalation anesthetics, they are eventually absorbed into the blood stream. During this process they cause irritation of the mucous membrane of the nose, throat, trachea, bronchi and lungs, not mentioning changes in blood chemistry. It is very evident that in the use of an intravenous anesthetic this method is short-circuited, the drug being injected directly into the blood stream and reaches the brain centers in less than ten seconds after the initial injection. There is produced no respiratory irritation, no laryngeal spasm, no excess salivary secretion, no excitement, and induction is rapid, smooth and quiet. Patients under pentothal rarely perspire and their skin is usually warm and dry. There is no period of excitement or struggling, and no orderlies are required to restrain the patient. The patient reaches the third stage of surgical anesthesia in less than two minutes. The fractional method of administration eliminates the uncertainty of safety. The drug is rapidly detoxified and eliminated, and the patient awakens as from a

deep, natural sleep without nausea or vomiting.

Some of us will say that an intravenous anesthetic is uncontrollable. This can best be answered in the following manner: Inhalation anesthesia, as nitrous-oxide or ether, is administered by the intermittent method. Enough anesthetic is administered to produce the desired effect. When surgical anesthesia has been established, the anesthetic is either discontinued for a period or very lightly administered from time to time. The same is true of intravenous anesthesia. A sufficient quantity is given to produce the desired effect, and then the drug is discontinued completely and small amounts are given as the surgical procedure demands. In this way it is completely under our control throughout the operative procedure. It should be remembered that any drug that produces a rapid effect is potentially dangerous and should be administered only by an experienced anesthetist.

The indications for the use of pentothal are "the sicker the patient the greater the indications for its use." This drug has no effect on cardiac muscles, does not alter metabolism, has no effect on blood sugar or blood chemistry, and no effect on blood pressure. It does not decrease urinary output, has no effect on liver function which has been proved by bromsulphthalein tests. Electrocardiographic tracings taken before and after pentothal administration show no changes whatsoever. I have personally administered pentothal to asthmatics, hypo- and hypertensive individuals, patients who have had recent coronary occlusions, decompensated cardiacs, patients with emphysema, nephritics, diabetics, patients with gallbladder disease, advanced pulmonary tuberculosis, and patients in shock. Pentothal is also used to control convulsions. I can well recall a patient to whom I was administering ether in a circuit filter, who was being operated upon for an appendectomy, when suddenly without any warning, he went into convulsions. The convulsions were general and the patient was cyanotic. I immediately gave him 2 cc.

of a 2½ per cent solution of pentothal, and his convulsion ceased immediately. The operation was continued and he made an uneventful recovery. Pentothal may also be used for induction in the patient's room, preliminary to a general anesthetic. It is also used as a supplemental anesthetic if a spinal begins to wear off before the end of the operation.

The contraindications for the use of pentothal sodium are first, age. Patients below twelve years of age do not tolerate intravenous barbiturates. They require very large doses and they have a poor anesthesia range. That is, they are either too light or too deep and have a tendency to develop respiratory depression. Children below the age of twelve as a rule do not have very good veins to inject. Pentothal sodium is contraindicated if the sulfonamides have been given prior to operation. The sulfur in the sulfonamides retards the elimination of pentothal. However, if the sulfonamides are discontinued for twenty-four hours prior to operation, pentothal may be given with safety.\* Pentothal is not given in cases of neck tumors that encroach on the glottis or trachea.

Premedication is given to have a quiet, peaceful patient in a "I don't care what happens attitude." Seconal, gr. 1½, is given the evening prior to operation, first to give the patient a good night's rest, and secondly, to determine if the patient has an idiosyncrasy to a barbiturate. In the morning, two hours prior to operation, the patient is given another 1½ gr. of seconal, and then thirty minutes before operation the patient is given pantapon gr. ½ and atropine sulfate ¼<sub>150</sub> gr. by hypodermic. When the patient arrives in the operating room, he is quiet and many times asleep. Properly premedicated patients have a quiet, smooth induction, there is no excite-

\* Since this manuscript has gone to print I have changed my views concerning the administration of pentothal to patients who have been receiving sulfonamide therapy. I have given pentothal to patients who have received sulfonamides for days, up to and including the day of operation without producing any harmful results from this combination.

ment, no salivary secretion, no laryngeal spasm, and they require less anesthetic as compared to patients who are not pre-

dissolved in 40 cc. of sterile, distilled water. Agitate solution until pentothal goes into a clear solution. Each cc. contains 25 mg. of



FIG. 1. Shows apparatus holding syringes, three-way valve, glass containing pentothal solution, and small rubber tubing to which is attached the tube from the intravenous fluids.

medicated. The only time I reduce my premedication is in individuals past fifty-five because they require less pentothal to produce surgical anesthesia. Nevertheless, I always give atropine  $\frac{1}{150}$  gr. as this prevents laryngeal spasm, hiccup and respiration depression.

*Technic Employed.* The patient is given premedication in his room and then brought to the operating room. He is placed in the proper position on the table, the operative area is surgically cleansed and draped. The intravenous solution is then prepared in the following manner: 1 Gm. of pentothal is

pentothal, thus making a  $2\frac{1}{2}$  per cent solution. The arm selected for the injection is placed outstretched on an armboard. A good vein in the antecubital space is located and the area is cleansed with alcohol and iodine. The operative area is draped, the syringe containing the pentothal is attached to a holder, and the three-way stop cock is attached to the Luer syringe. The solution is then allowed to flow through the apparatus to displace the air in the tubing. A tourniquet is applied above the selected vein, the needle is inserted, bevel up, to a point of return flow

of blood in the Luer glass tip; the tourniquet is removed and the solution is slowly injected at the rate of 2 cc. in thirty

the patient falls back to a quiet sleep. Relaxation of the jaw occurs very early, and attention to this physiological process



FIG. 2. Shows position of valve for administration of pentothal.



FIG. 3. Shows position of valve for aspiration of additional pentothal solution. The small rubber tube on the three-way valve is inserted in a glass containing pentothal solution; draw up on plunger of syringe until filled.



FIG. 4. Shows position of valve for administration of intravenous fluids, such as glucose, normal saline, plasma or blood. The tube from the intravenous fluids is connected to the short rubber tubing on the three-way valve.

seconds. Two small strips of adhesive are now placed over the hilt of the needle to keep it in position. I keep the bevel up so that I can watch for extravasation of pentothal. No definite rule can be set as to the rate of injection because individual idiosyncrasies vary, one individual requiring 2 cc. for complete anesthesia, whereas another individual will require from 6 to 10 cc. My main guide to the depth of anesthesia depends on the reaction of the patient to the drug. The onset of anesthesia usually occurs in thirty to sixty seconds, with deep sighs, slurring speech, relaxed jaw, depressed respiration, absence of lid reflex and centrally fixed eyeballs. After the initial injection of 2 cc. I usually wait thirty seconds before giving more solution, then  $\frac{1}{2}$  to 1 cc. may be added from time to time as the operation progresses. Slight movement of the extremities, phonation, increased depth and rate of respiration call for an increase in dosage of pentothal, and

requires the immediate insertion of a rubber air way.

I believe that the two most important signs of surgical anesthesia are quiet, regular, depressed respirations and abolished lid reflex. When the patient begins to come out of anesthesia, the respirations increase in rate and amplitude, and the lid reflex becomes active, associated with an oscillating eyeball. If the patient is watched very carefully throughout the operative procedure,  $\frac{1}{2}$  to 1 cc. of pentothal will increase the depth of anesthesia in thirty seconds. As soon as surgical anesthesia is established and not until then, do I permit the surgeon to make his incision. Because if the incision is made before the onset of surgical anesthesia, almost twice as much pentothal is required and relaxation is very difficult to obtain, especially in abdominal surgery. I make it a rule to tell the surgeon not to begin until I notify him that "the patient is ready." When surgical anesthesia

begins I immediately apply a mask to the patient's face and allow 300 to 400 cc. of oxygen to flow through a circuit carbon-dioxide filter. This tends to relax the patient and keep him pink throughout the operation. If at any time respiration becomes too depressed, I make gentle pressure on the rubber breathing bag at the beginning of inspiration. The oxygen is continued throughout the operation. At the end of the operation I usually allow the patient to rebreathe a mixture of 5 per cent mixture of carbon-dioxide and 95 per cent oxygen for one minute to stimulate respirations, thus decreasing the possibility of atelectasis.

Intravenous fluids, as glucose 5 per cent or normal saline, are started as soon as possible. The tube from the intravenous solution is connected to a rubber tube on the three-way valve and the solution is allowed to run in slowly, simply by turning the hand on the three-way valve to the left. If more pentothal is required the little hand is turned for straight through,  $\frac{1}{2}$  to 1 cc. of pentothal is allowed to flow slowly, and the valve hand is then turned to the left allowing the flow of intravenous fluids to continue. The intravenous fluids give the patient a "good drink" while he is asleep, replaces fluids lost by hemorrhage, supports the circulation and prevents plugging or clogging of the intravenous needle. With the apparatus so adjusted I am able to take care of the patient without any other assistance for my hands are free to hold the jaw of the patient if necessary, and at the same time control the flow of intravenous solution and give pentothal at intervals as required. Ordinarily  $1\frac{1}{2}$  to 2 Gm. of pentothal are required for operations lasting from one and one-half to two hours. As I have said before, there are individual idiosyncrasies to pentothal. I can recall one case, a physician's wife, to whom I gave pentothal for the removal of renal calculi. The kidney was exposed and several calculi were removed; on comparison with the x-rays taken before operation, there were still several more calculi in the kidney. A portable x-ray was brought to the operat-

ing room, x-rays were taken and developed, and the missing calculi were located and removed. Of course this took time, in all, three and a half hours, and the patient required only  $1\frac{1}{2}$  Gm. of pentothal. I usually prepare 1 Gm. of pentothal in 40 cc. of water before operation, and if more is necessary it is easily prepared and administered. To date the largest amount of pentothal given was  $2\frac{1}{2}$  Gm. This was given to a very robust young man for the excision of a large growth which completely surrounded the left shoulder, the operation lasting three hours.

Pentothal is cumulative in its action, the longer the anesthesia continues the less is the amount required to maintain anesthesia. I usually give pentothal until the beginning of closure of the wound. From this point on no anesthesia is required, provided a certain depth has been maintained throughout the operation. Consciousness returns gradually, depending on the premedication, duration of the operation, and the amount of pentothal administered. If the patient is asleep at the end of the operation, I leave the airway in until consciousness has returned. Postoperative sleep varies considerably. Some patients awake immediately in the operating room, others have slept from two to six hours postoperatively. During the postoperative sleep respirations are full and regular, color is good, the pulse is of good volume, and the skin is warm and dry. If the patient is asleep when he leaves the operating room, I place a "paper butterfly" on his upper lip. This butterfly moves with respiration, thus making it easier to watch respiratory movements. If an airway has been inserted, I attach a small butterfly to the breathing tube leaving the airway in until the patient has regained consciousness.

Postoperatively these patients can take fluids on awakening as we are not dealing with an anesthetic that causes nausea or vomiting. If medication is needed for post-operative pain, pantapon gr.  $\frac{1}{3}$  may be administered every four hours for twenty-four hours.

Equipment consists of two 20 cc. Luer syringes; two No. 20-21 gauge needles, one rack for holding syringes, one three-way valve, two pieces of rubber tubing, one Luer glass tip and one medicine glass for mixing solution.

When I first began using pentothal I gave one ampule of coramine postoperatively to stimulate respiration. Oddly enough, I found out that some of these patients vomited considerably. On discontinuing the administration of coramine there was no vomiting. I cannot account for this reaction. No respiratory stimulants are given now.

I have given sodium pentothal satisfactorily for many major surgical operations and have seen no harmful results. I have utmost faith in its safety and have always worked on the adage, "don't give something to someone that you wouldn't take yourself." If pentothal is given with care and administered in fractional doses by a trained anesthetist, I am firmly convinced that it is the latest advance in modern anesthesia.

The operations performed under pentothal sodium are as follows: Appendectomy, amputation of extremity, bottle operation for hydrocele, cesarean section, cholecystectomy, colostomy, epididymectomy, epididymovasotomy, evisceration closed, enucleation, gastric resection, hemorrhoidectomy, herniorrhaphy, hydrocele, hysterectomy, illiostomy, mastoidectomy, nephropexy, nephrotomy, nephrectomy, nephrolithotomy, orchidectomy, perineorrhaphy, removal of pilonidal cyst, removal of prostate, tonsillectomy, ureterolithotomy, vaginal hysterectomy, and Wertheim-Watkins repair.\*

I wish to emphasize that in all of the aforementioned operations pentothal sodium was the sole and only anesthetic employed and no supplemental anesthetic was necessary.

\* Since this manuscript has gone to press I have given pentothal for over fifty ophthalmic operations including iridectomy, LaGrange (anterior sclerotomy), corneal-sclero trephine, cataract, keratoplasty, Walker operation for retinal detachment, enucleation, modified Hess operation for ptosis and dacryocystectomy.

The youngest patient was fifteen and the oldest was one hundred two years of age. The average duration of anesthesia was one and one-half hours. Females out-numbered the males since many of the operations were performed by gynecologists. The shortest operation was forty-five minutes, the longest was three and one-half hours.

#### CONCLUSIONS

I have not found a single contraindication for the use of pentothal as a general anesthetic agent and have administered this drug solely in almost every type of major surgical procedure.

Intravenous pentothal anesthesia must be administered only by a trained and experienced anesthetist.

The intermittent method of administration eliminates the uncertainty of safety. We must not forget that pentothal sodium is a potentially dangerous drug, but in the hands of an experienced anesthetist who knows how to treat complications, it is comparatively safe.

It is recommended for good and bad surgical risks, and even to patients in shock. It is especially indicated in those patients who present some disease of the respiratory tract.

Multiple administrations may be given without any untoward reaction.

In all these cases I have not had one death attributed to this drug either during or after the operation.

The equipment is simple, the administration easy and it is nonexplosive.

The use of  $2\frac{1}{2}$  per cent solution decreases the possibility of venous thrombosis, and extravasation causes very little tissue irritation.

The technic I employ allows the anesthetist to take care of the patient without any assistance.

Its action is rapid and peaceful both in induction and emergence; it leaves no after effects.

Intravenous pentothal sodium approaches the ideal anesthetic for major surgical procedures.

# SYMPTOMS FOLLOWING CHOLECYSTECTOMY

## SOME BRIEF CLINICAL NOTES

DEAN MACDONALD, M.D.

ST. CATHARINES, ONTARIO

ALTHOUGH the incidence of symptoms following cholecystectomy cannot be definitely determined, few will deny that such symptoms are not uncommon and that the subject receives too little attention, both pre- and post-operatively. This statement is upheld by the fact that only two references can be found in the Year Books of General Medicine and General Surgery from the years 1934 to 1941 inclusive. It is surprising that more thought is not given to such an important subject because it is recognized that symptoms do follow cholecystostomy, and that secondary operation is often necessary following gallbladder drainage (cholecystostomy is sometimes indicated as an intentional first-stage procedure). Many articles deal with certain symptoms, but few discuss all the phases of the subject. This paper presents a general but brief discussion of the principal factors involved.

A conservative all-inclusive estimate of those patients who are not cured by cholecystectomy probably varies between a high of 35 per cent and a low of 15 per cent; i.e., approximately 1 in 3 to 1 in 6. This statement will stand much thought. A patient, after failing to receive satisfaction following operation, often goes elsewhere because he is afraid that the same unsatisfactory results may be repeated. Hence the first operator may not know about the postoperative complaints, and does not appreciate them as actualities, even though he "gets the blame." However, *thorough follow-up work should reveal all poor results.* This is an important, but often neglected, chapter in the story of a patient's illness. The immediate future assumes the all-important rôle, whereas the ultimate result should be just as impor-

tant, and many times is much more so. An operation is not successful just because the patient does not die. A sincere attempt should always be made to learn about the patient's health long after the immediate postoperative care has stopped. Statistics from teaching hospitals show that 90 per cent of patients, *with calculus disease*, obtain good results. This is because the diagnosis is correct, the patient well categorized, the proper surgical procedures performed and medical treatment carried on postoperatively.

In non-calculus disease the percentage of good results is distinctly less, and therefore such patients demand the most profound consideration before surgery is undertaken. The writer believes that there is a very definite reason for the relatively good results obtained by cholecystectomy for calculus disease, and the comparatively poor results obtained by the same operation for non-calculus disease. In the former, one of the primary symptom-producing mechanisms is removed, namely, calculus; in the latter the principal symptom-producing mechanism—hepatitis, cholangitis, common duct disease, pylorospasm or sphincter spasm, etc.—is not removed and, indeed, is only attacked indirectly by cholecystectomy. There is increasing evidence to show that biliary perfusion through the common duct will directly attack the underlying pathological disorder and decrease, if not remove, the chief and basic symptom-producing factors in non-calculus disease.

Many non-calculus patients have received symptomatic relief by carefully supervised medical treatment; but when this is so, the treatment is not slip-shod or haphazard as, for example, is the majority of ulcer therapy. Medical therapy, either

pre- or postoperatively, is a neglected though important, subject. It is better to get symptomatic improvement with medical therapy than poor or fatal results with surgical therapy. In other words, it is better to be alive with biliary disease than dead without it, from the viewpoint of the physician as well as the patient. Gordon says the same thing in a different way; he notes that "an element of perspective might preserve a number of middle-aged citizens to belch gas even to old age, rather than quell that belching prematurely and permanently," and he adds, "Is it not better to bear the ills we have than to flee to others we know not of?" Someone else has said that there are more patients walking around with adhesions about their biliary system than have ever been cured by surgery. However, once the indications for surgery are definite, medical treatment must be replaced by operation as soon as adequate preoperative preparation has been completed. If these precautions are always followed and sufficient care given to correct and complete diagnosis and to the principals of surgical treatment, the percentage of patients who will suffer following cholecystectomy will be greatly reduced.

#### MINOR COMPLAINTS

A small number of patients will have symptoms of varying severity, and of either major or minor importance, following operation for a short period. These complaints usually subside. Only if they persist or reappear do they constitute the so-called, and poorly named, postcholecystectomy syndrome. (The symptoms do not constitute a syndrome.) Thoughtful and carefully supervised treatment and adequate postoperative care will relieve all but the serious surgical cases. Among the temporary or non-operative causes of postoperative discomfort or pain which should be considered are sphincter spasm, pylorospasm, blood, mucus or débris in the ductal system (Fig. 8), liver or gut trauma, and a T-tube producing common duct irritation

or obstruction. (Fig. 9.) Many postoperative troubles could be prevented if we would only realize that they can always occur. Prevention is better than cure, even when cure is possible.

The longer after operation that symptoms appear, and the longer they last, the more serious do they become, and the more likely they are to be organic in origin, (i.e., months rather than weeks or days). Symptoms appearing fifteen to twenty years later are not likely due to calculus disease. (Fig. 10.) If a T-tube is in place it can often, but not always, be determined by a cholangiogram whether such symptoms are due to ductal obstruction and if so, the type and location of the lesion. Thirty-five per cent diodrast has been found to be the best contrast medium. Other writers prefer a 70 per cent solution. This is now hard to obtain and has been used in only a few cases in this series.

#### MAJOR COMPLAINTS

The principal causes of major symptoms following cholecystectomy can be enumerated as follows. They cannot, however, be listed in the order of their relative frequency or seriousness because these often depend upon the temperament and disposition of the patient, as well as the surgeon: (1) wrong diagnosis, (2) residual disease, (3) calculi in the common duct, (4) common duct stricture, (5) partial or intermittent obstruction of the common duct or duodenum, (6) functional disturbances, (7) lack of, or an indifference to, medical treatment, (8) traumatic neuroma in the wound, and (9) malignancy.

A wrong diagnosis is the most common cause of unsuccessful treatment in practically all patients, but in no other condition is it more important than it is in biliary disease. Cholecystitis is not confined to "flatulent females who are fair, fat and forty" and who cannot eat pies, cakes and pastries, nor is it true that this type of person usually has gallbladder disease. A correct diagnosis will always be the basic fundamental and the rock foundation of all

successful medicine. It has been called the trump card in the game of treatment. For the sake of emphasis it can be said that

work is less important than many consider it to be, and Wetherbee points out that, when properly used, it only confirms the

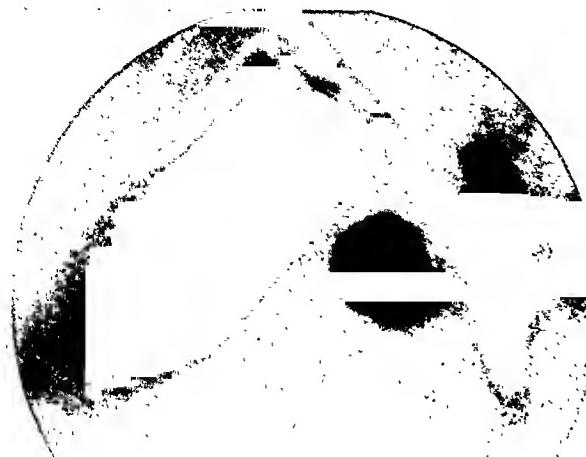


FIG. 1.

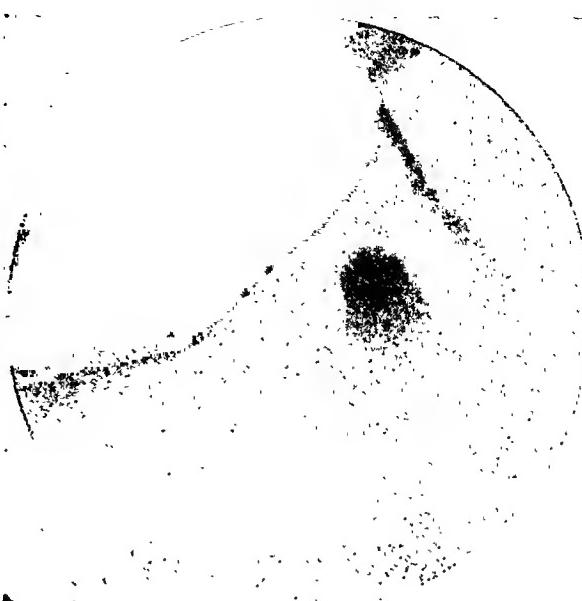


FIG. 2.

**FIGS. 1 AND 2.** Gallbladder, cystic duct, common duct and duodenum (partially) visualized after injection of dye through mushroom catheter in bladder. These show two potential causes of symptoms following cholecystectomy, namely, (1) the case with which the common duct can be strictured by trauma, (organic); (2) reverse duodenal peristalsis (functional). 1. The pouch of the bladder lies close to and actually seems to indent the common duct. The pictures illustrate clearly how a clamp or dissecting scissors could injure the choledochus during careless dissection, thus producing a traumatic stricture. This possibility would be greatly increased if inflammation (which was not present in this case) produced an adherence of bladder wall to duct wall. 2. Reverse duodenal peristalsis is seen in Figure one. The first dye to enter the duodenum has been propelled in a reverse direction, and in Figure 2 the entire second portion of the duodenum is filled. This is a cause of symptoms due to functional changes (Ivy).

Another finding of interest and of importance is a short, convoluted, and narrow, cystic duct which leaves the bladder near its distal end and follows a tortuous course (picture not clear due to weight of patient—230 pounds). This is a real cause of non-calculus biliary colic preoperatively as well as a postoperative cause of pain if the bladder is not removed and the cystic duct produces any degree of obstruction to the outflow of the remaining bladder bile. This patient had preoperative jaundice and colic incorrectly diagnosed as calculus colic. Roentgenologically and macroscopically the bladder and ducts were normal and the viscera was not removed. Postoperative cholangiograms revealed the cause of the colic to be the cystic duct. Perfusion has produced a cure to date (thirty-nine months).

wrong diagnoses are the result of a poor history or otherwise insufficient study of the case, and that they are rarely due to inherent difficulties or rare conditions. Diagnoses are too often made on several symptoms only, or from an incomplete or misinterpreted x-ray study, which is often done before a thorough and enquiring history is taken and studied. It is impossible to stress too often the importance of the history, of the patient's life as well as of the symptoms. It is of more diagnostic importance than the x-ray. (Fig. 11. Cholangiogram negative; history positive; common duct calculus present.) Laboratory

clinical diagnosis, that it seldom disproves it, and hardly ever establishes it. However, in biliary disease with or without jaundice, experienced interpretation of a properly conducted x-ray and laboratory study is very helpful in evaluating clinical symptoms. There are so many functional and pathological conditions which may produce symptoms resembling gallbladder disease that the preoperative investigation may be one of the most painstaking and tedious in medicine; on the other hand, the diagnosis can be remarkably accurate if sufficient time and trouble are taken.

Because the majority of diagnostic errors are preventable, and although no one can "sit in the scouter's seat and hurl

large bowel represent one of the most usual causes of a wrong diagnosis (irritable colon, spastic colon, unstable colon). This is not



FIG. 3. This picture shows a potential cause of common duct stricture. A very tortuous and elongated cystic duct passes under the common duct and enters it on the medial side. If the cystic duct is pulled or "tugged" toward the clamp, it is evident that the common duct might easily be grasped before the end of the cystic duct, if dissection has not been clean and the ductal juncture not clearly visualized. The common duct may be injured in any one of many ways (clamp, suture, needle, etc.) and a traumatic stricture of varying degree thus becomes a probability. Perfusion performed for three months postoperatively. The patient is symptom free three years after operation.



FIG. 4. This figure illustrates how a cystic duct can produce partial obstruction to the outflow of bladder bile. It is a clinical cause of non-calculus biliary colic. It may also be a factor in postoperative symptoms when the bladder is not removed. This patient, as the one in Figures 1 and 2, had a normal bladder by roentgenologic examination and by macroscopic examination on the operating table. The bladder was not removed. Preoperative complaint of biliary colic for three years. No complaint for forty-seven months postoperatively following perfusion through a mushroom catheter in the bladder.

the cynic's ban," the difficulties associated with diagnostic problems should always be discussed in a constructive way. Apropos of this, someone has said that diagnostic "problems" are nothing more than instances of a common disease presenting unusual symptoms. This is a good axiom to remember because the more definite the diagnosis, the better will be the end results of the correct treatment. In the absence of definite indications for surgery, active medical treatment is indicated. It must never be forgotten that surgery will not correct physiological dysfunctions. These are more common than generally recognized.

Changes in the motor activity of the

uncommonly present with organic gallbladder disease. Reliable statistics show that as many as 20 to 30 per cent (maybe more?) of patients with non-calculus cholecystitis, who have symptoms following cholecystectomy, are relieved by close attention to normal bowel function. The next most common errors relate to heart disease, peptic ulcer, and kidney or uretral disorders. Hydronephrosis, a urinary calculus, pyelitis, or a stricture of the ureter, with or without a normal urine (single specimen) are the usual culprits, although a uretral stricture is more commonly the cause of appendicitis-like complaints. These latter conditions more commonly simulate

calculus disease. Other uncommon conditions which may have to be considered are gastritis, pancreatic disease, diaphragmatic

Also in this category of wrong diagnosis can be mentioned that large group of patients who are not well selected for

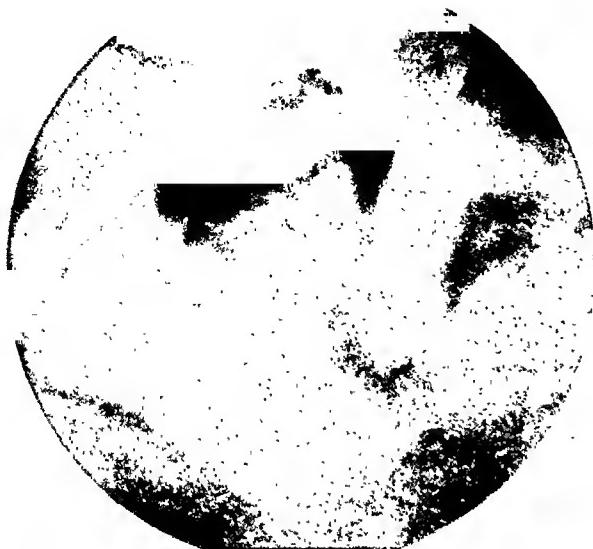


FIG. 5. A non-traumatic inflammatory stricture of the distal and retroduodenal segment of the common duct. This is probably associated with pancreatic disorder (chronic pancreatitis) and long standing biliary tract disease. At operation a chronically fibrosed and contracted calculus gallbladder was removed. One year post-operatively symptoms were persistent and severe, and a diagnosis of remaining common duct calculus was made, even though none had been found at the first operation. Colic and jaundice were absent. Choledochotomy revealed no stones and a cholangiogram showed the symptoms to be due to this inflammatory stricture. Perfusion gave temporary relief but this could not be continued due to home conditions. The T tube was, therefore, used to detour the bile into the stomach, and symptoms have been markedly lessened in the intervening thirteen months. Indeed the only complaint is the vomiting of bile which gives relief to an epigastric distension and distress. This is probably due to a chemical gastritis which would have been obviated had the jejunum been used instead of the stomach. The T tube has not yet become "plugged." Carefully supervised medical treatment is putting off the "evil day" as long as possible, and if the flow of bile is kept free it may not occur.

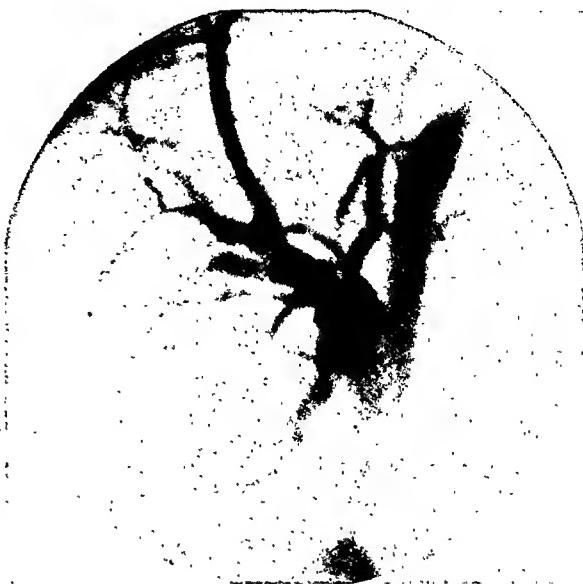


FIG. 6. A moderate degree of hydrohepatosis is shown. It may be a cause of postcholecystectomy symptoms and is the result of intermittent and partial obstruction. (This is not so great as seen in Figure 11.) Jaundice or an increased icteric index were never present. Typical biliary colic was also absent. The symptoms were dyspeptic in nature and epigastric in location. The different densities are due to different focal distances; some of the biliary channels are near the anterior and some near the posterior surface of the liver.

surgery. The indications for surgery is the subject of another paper and cannot be discussed here, but it should be stressed that patients with biliary disease deserve more serious consideration than almost any other group, especially if jaundice is or has been present. A bromsulphalein dye curve, (not a single estimation), will show early deficiency, and often give invaluable assistance in the differential diagnosis of liver disease. It also indicates the liver reserve. Liver tests are not as helpful when icterus is present because the presence of liver disease is obvious. The danger is in the unknown case.

*Residual disease* is usually concerned with, and confined to, the biliary tract. It consists principally of hepatitis, pancreatitis, ductal calculi, sphincter imbalance, choledochitis and cholangitis, all of which

hernia, esophageal disease, food allergy which is too often forgotten, and diseases of the liver. These can present almost any picture resembling indigestion. Functional changes which may enter a differential diagnosis are duodenal or pyloric spasm, "nervous indigestion" and gastric neurosis.

are capable of producing moderate to severe clinical complaints. These are complications of, or resultant conditions of,



FIG. 7. An example of the clinical and practical value of routine cystic duct drainage following cholecystectomy. The catheter in the cystic duct permits a cholangiogram to be made in all those patients whose common duct is not opened. Thus the incidence of unrecognized remaining common duct stones is reduced, as are the secondary operative morbidity and mortality rates. In this instance the cholangiogram revealed a single calculus remaining in a dilated and obstructed common duct. This picture was made eight days following operation, as a routine, and the calculus was removed before the patient left the hospital. Although this instance was embarrassing for the writer, it was safer for the patient than waiting for symptoms and advanced liver disease to bring the calculus to our attention.

biliary disease, and probably should be grouped under "incomplete diagnosis" or wrong diagnosis rather than residual disease, because they are "part and parcel" of the gallbladder disorder, and the original diagnosis, if complete, should include such complications. Disease which will give symptoms after operation should be noted before or at operation. A patient will receive no relief of symptoms after the removal of a gallbladder, even when it contains stones, if the indigestion resulted from common duct calculi. (Figs. 7 and 11.) The associated conditions in the liver and pancreas are more difficult of both diagnosis and treatment than are those not

associated (heart disease or peptic ulcer). The treatment of the former is part of the operative treatment and their persistence after operation is often due to insufficient drainage of the ductal system. The judicious use of ductal perfusion with heated fluids will probably play an important part in the reduction of the incidence of these conditions. The liver is, for practical purposes, nearly always involved, but in the past has never been treated directly or specifically; it has been treated indirectly by the removal of an infected gallbladder or a short-lived ductal drainage. Direct and specific treatment will result from perfusion. The more experienced the surgeon and the better his judgment, the less will be the residual disorders. It can bear repeating that it is the good head rather than the good hand which makes the good surgeon, and that he is as good, if not better, outside the abdomen, than inside it.

*Stones in the Common Duct.* These may be left at the time of cholecystectomy (Figs. 7 and 11) or they may form later. Recent articles have shown clearly that calculi removed from the common duct years after cholecystectomy may not be the same type as those previously removed with the gallbladder. The presence of stones is always of the most serious potential consequence. It is obvious, therefore, that the general practitioner faces this danger every time he performs what is unfortunately referred to as a "simple cholecystectomy." There is nothing simple in gallbladder surgery, even though the operation may be technically easy. This is proved by the high percentage of unsatisfactory end results. Stones or other disorders may sometimes be present in the common duct when stones are absent in the bladder, but of greater importance is the failure of the operator to suspect ductal stones *every time* calculi are found in the bladder. In practical fact, *any patient who is a surgical consideration may have ductal disease*, and it is unfair to subject a patient to biliary surgery unless the surgeon is well qualified to perform any unexpected pro-

cedure that may present itself. Plato, in his "Republic," preached commandingly and convincingly that a man should not hold

cholecystectomy the writer has for some time been placing a small catheter in the cystic duct at operation, in those patients



FIG. 8. Female, age seventy-three years. First panel shows a distended non-calculus duct twelve days following removal of five stones from the common duct. Second picture taken three weeks later and two days after an attack of severe colic, epigastric distress and vomiting. If an indwelling T tube had not allowed this x-ray study, a diagnosis of remaining calculi would have been reasonable and a secondary operation might have been considered or even performed. However, the second panel shows the terminal duct filled with mucus. Operation and its great risk were therefore avoided. The third panel shows the clear duct following the dissolution of the mucus by carotid and perfusion. The terminal portion of the pancreatic duct is filled with dye. This is a good example of one of the common causes of symptoms following cholecystectomy combined with common duct drainage. The excessive mucus secretion was probably due to the presence of the T tube without perfusion which was stopped when the patient went home. All such tubes must be thoroughly and continually washed out. Perfusion was continued for two weeks and the tube withdrawn. The patient was symptom free for nine months. In the center panel, if the shadow lying alongside the lower wing of the T tube was not so pointed, the concave curve in the shadow just below the same area could be interpreted as the negative shadow of a small calculus. The same is true of the two negative shadows distal to this. Serial cholangiograms are also necessary to distinguish such artefacts and should always be made.

public office, or be trusted with great responsibilities, until he had reached fifty years of age, and had been apprenticed since youth to one or more men who had held these offices before him. In this way, the thesis proceeded, when such a well trained man reached the time when he would "take over," he was capable and competent. Such an idea, modified of course, must some day be introduced into surgery, which is, as Moynihan has said, "the greatest art ever put into the hands of man for his own advancement." Unfortunately, deterioration is creeping in and this must be prevented at all costs.

To obviate the possibility of leaving stones in the large ductal system following

whose common duct was not explored. This allows every patient to have a cholangiogram made before leaving the hospital and if stones are present they can be removed. Thus no person leaves the hospital with stones remaining in the common duct. This is much safer and easier, for both the operator and the patient, than waiting for symptoms to indicate a diagnosis in later years. At this time the risk has decreased and the morbidity and mortality have increased proportionately. (It is, of course, ideal to perform cholangiography on the operating table.) Artefacts must be recognized in all common duct x-ray studies. (Figs. 8 and 13.)

In diagnosing common duct stones after cholecystectomy the duodenal tube is of value. The presence of cholesterol crystals



FIG. 9. Illustration showing a cause of symptoms following cholecystectomy due to poor technic, namely, partial obstruction of the common duct. This is preventable. No bare areas should be left at operation. In this picture a bare area on the hepatoduodenal ligament and/or one on the lower edge of the bladder bed have become attached one to the other, and the common duct has been drawn up to produce a definite kink. Pictures taken nine days postoperatively showed a normal straight ductal system. This picture was made seven weeks after operation. The obstructive kinking had therefore been produced in the intervening six weeks. Symptoms were mild for one week; one attack of colic occurred as severe as before surgery; opiates were required. Other causes possible but all complaints disappeared when tube was removed. In such instances the tube, which may act as an obstructing agent, should be removed and the free flow of bile stimulated (increase amount of flow and relax sphincter).

in the duodenal drainage is suggestive, and the finding of calcium bilirubinate is almost "sure proof," but the combination is, for practical purposes, pathognomonic of choledocholithiasis. However, stasis resulting from stricture will often give the same findings. If sterile intubation shows the repeated finding of the colon bacillus or of a strain of streptococcus, cholangitis is also present. This latter procedure is difficult, if not impossible, to perform in general practice, but everybody should be able to

do, and interpret the findings of, ordinary drainage.

*The differential diagnosis of stone or stricture, as the cause of symptoms, is not as important as the realization that serious ductal disease is present, that it is usually progressive, that it promotes advanced liver disease and finally liver failure, and that early and expert surgical treatment is the only method of cure.* However, calculus is much the commoner finding. The jaundice produced by calculus is usually more frequent in appearance, more intermittent in degree, and less progressive than is that produced by stricture. The diagnosis of inflammatory stricture may sometimes be made before it produces jaundice, which is a sign of a late and dangerous stage. As long as bile is flowing into the duodenum there are not likely to be many clinical signs of icterus. Symptoms predominate. Complete obstruction and incomplete obstruction are two different conditions and the causative factor is usually different. The symptoms of early partial obstruction are vague (in definition but not in sensation), and consist first of the dyspepsia of liver dysfunction, then the nausea and vomiting of ductal distention, later of pain or colic and still later of jaundice. Midline pain high in the epigastrium in the presence of known biliary disease should always bring ductal disease into a differential diagnosis. Thus it may be possible to diagnose stricture before the appearance of jaundice. The icteric index should always be closely followed in any patient who has symptoms following cholecystectomy.

A stone is not uncommonly left in the cystic duct stump and this is capable of producing postoperative colic, but it is a rare cause of postoperative complaints compared to the incidence of common duct calculus. Occasionally, stones may roll down from the intra- or extrahepatic ducts. Débris, sand, gravel, clot, etc., are capable of forming the nucleus of a ductal calculus if the immediate postoperative drainage is of short duration. The prevention of such symptoms is most desirable,

and prolonged biliary perfusion with heated fluids should prove itself of more value in this respect than the short-lived and often

a T tube or catheter is left in the common duct.

In summation it can be said that, for



FIG. 10. Female, sixty-seven years of age. Cholecystectomy eighteen years previously with no symptoms until one year before operation. Complaints are not, therefore, likely related to previous cholecytopathy. Jaundice on three occasions in previous six months, accompanied by nausea, vomiting, and high midline epigastric distress. Duodenal drainage showed calcium bilirubinate crystals in abundance. Diagnosis of intermittent extra-hepatic obstruction, with the law of averages favoring new stone formation. Operation revealed no stones. Pancreas was apparently normal. The stump of the gallbladder was easily identified and is clearly seen in the picture. Duct greatly enlarged and gallbladder stump distended more than could be accounted for by compensation following cholecystectomy. Cholangiogram made nine days after operation reveals a dilated common duet and bladder stump but the intrahepatic radicals are not dilated. The obstruction cannot, therefore, be complete, persistent or longstanding. The contour of the terminal portion of the common duet suggests—and some may say indicates or is even diagnostic of—a chronic pancreatitis producing partial obstruction. Primary or secondary liver failure or malignancy of the terminal duet could not be ruled out. Immediate postoperative course was uninterrupted, but the patient died three weeks later with a clinical diagnosis of cerebral thrombosis followed by hemorrhage. Autopsy was not obtained. (This case is presented through the kindness of Dr. Hurlbut.)

inadequate T-tube drainage. It is not reasonable to expect that disease which has often been progressing for years will completely disappear in twelve to fourteen days, which is the average length of time

practical purposes, jaundice appearing after cholecystectomy must be considered due to common duct obstruction (stone, stricture, or inflammation), although intrahepatic causes and extraductal pressure

must never be forgotten, especially malignancy. The clinical evidence of advanced obstruction consists in part, or in the whole,

*Common Duct Stricture.* In 80 to 90 per cent of cases this condition is traumatic in origin and is the direct result of cholecystec-

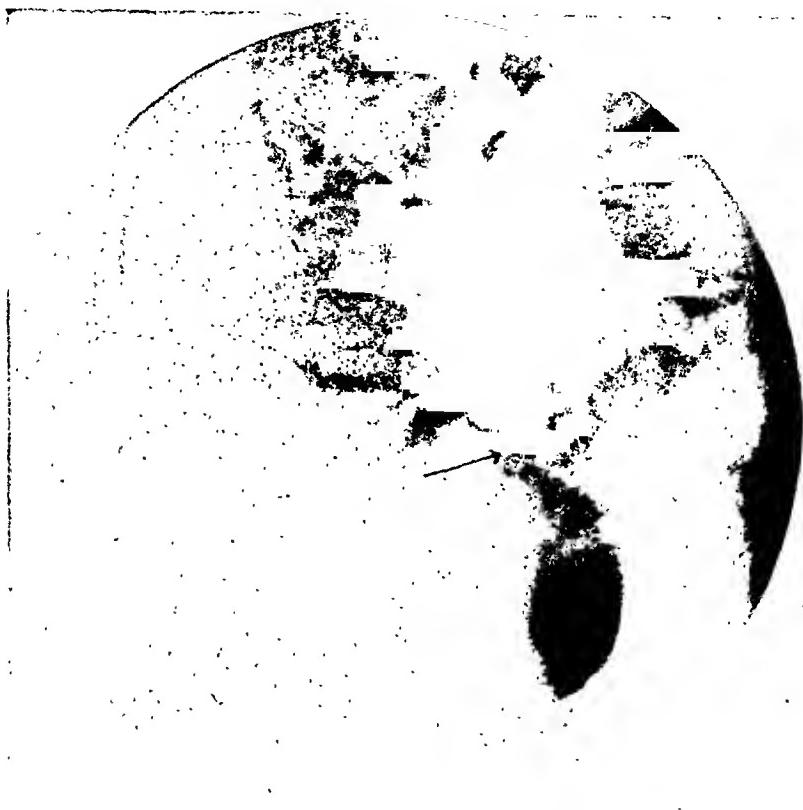


FIG. 11. Cholangiogram taken on the operating table before the duet was opened. History: drainage of gallbladder empyema three years previously and removal of bladder two years previously. Both operations were performed elsewhere. A fistula formed between the first and second operation. Since last operation clinical history almost pathognomonic of stone or stricture but history greatly in favor of remaining common duct stone. Although this cholangiogram indicated the presence of a stricture (arrow), and the absence of a calculus, the clinical history proved to be correct when a single cholesterol stone was found in the distal duct even though a large catheter, a probe and a dilator passed into the duodenum with ease. The calculus was not identified until the duodenum was freely mobilized. A great degree of hydrohepatosis is present. This is the result of persistent increased intraductal pressure due to long standing states of obstruction. The "trickle" of dye in the pancreatic portion of the duct suggests an accompanying chronic pancreatitis, itself producing some obstruction. This is a very good example of the most common cause of symptoms following cholecystectomy for calculus disease. The picture raises a question of the greatest clinical importance, namely, how much dye must overlie a stone in the common duet or kidney pelvis before the negative shadow is completely obliterated, and are stones other than cholesterol likely to be overlooked?

of biliary pain or colic, fever, jaundice, chills, and a persisting biliary fistula; whereas indigestion-like symptoms high in the epigastrium indicate an early malfunctioning ductal system. (This system starts in the liver and ends in the duodenum.)

tomy. Fortunately, this is not common, nor is it uncommon, and it is always a possibility. (See Figs. 1, 2 and 3.) *It must be considered in every case having symptoms following cholecystectomy.* The time interval between the operation and the appearance

of symptoms is of some diagnostic value in determining whether a stricture is due to technical faults (trauma, ligature, etc.)

All strictures do not produce a complete obstruction. One that is incomplete may give symptoms of only pain or dyspepsia,

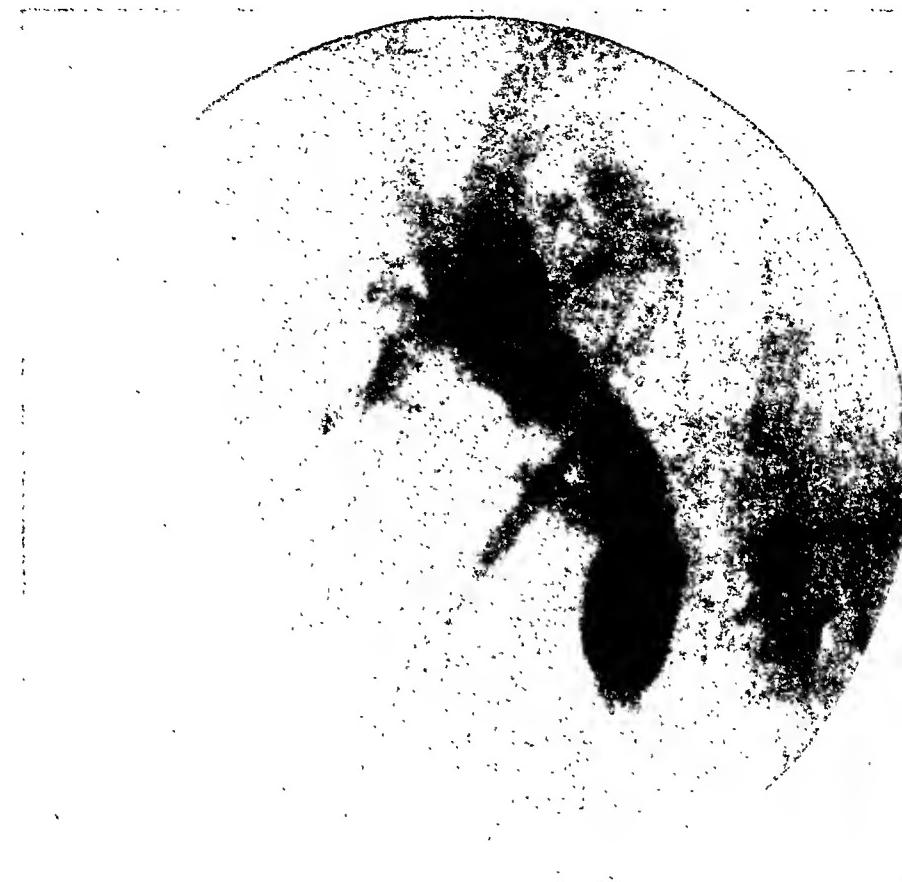


FIG. 12. Same case as Figure 11 eight days following operation. The principal difference is seen in the retroperitoneal portion of the duet where the dilatation is less. The concave curve below this point is not due to a stone because this contour changes considerably in serial exposures. These later pictures allowed more time to be taken and it can be said with reasonable certainty that no calculus remain. This is seen more clearly during the emptying phase following the inhalation of amyl nitrite. Morphine was not used to contract the sphincter. It has been found that this drug often contracts the lower end of the duet and narrows it enough to resemble pancreatic constrictions.

or inflammatory changes; the former usually appear at once and the latter weeks or months later. Either condition is most difficult to treat successfully. Removal of the gallbladder may, therefore, produce as serious a condition as can be found in surgery and one which is much more serious than the original complaint. For practical purposes the prevention of traumatic stricture is always possible if the ductal junction is clearly visualized in every case, and if the incidence and probabilities of anomalies of both ducts and vessels are not forgotten.

but serious states of obstruction are likely to be present if a biliary fistula follows the removal of a drainage tube, or the removal of a T tube if the duct has been opened, and more serious states of obstruction are probable if colic, jaundice, chills and/or fever are also present. A fistula may be the only sign of common duct obstruction, whether it be due to stricture or calculus. The latter is the more common cause. Indeed the valve effect of the fistula will reduce the increased intraductal pressure, and therefore its presence will lessen the incidence of symptoms and jaundice,

both of which are the direct result of this back pressure. However, such an overflow (and that is the only purpose a T-tube



FIG. 13. Artefacts must always be considered in the interpretation of cholangiograms. This picture shows an unusual one. Five serial pictures, which were repeated two days later, showed a negative shadow which was constant in size, shape and location and satisfied all the requirements of a calculus. However, as the duct drained after the inhalation of amyl nitrite, the shadow was clearly seen to be the eye in the catheter. Other artefacts are blood clots, mucus plugs, (Figure 8) and air bubbles. Although this picture does not show the negative shadow as clearly as it is seen in the x-ray view-box, it is an excellent example of the value of serial exposures before and after emptying of the duct. This is a must procedure. If it had not been done in this case, secondary operation may have been considered, or even performed. At operation the cystic and common ducts were clearly seen to pass separately under the duodenum. This is seen in the pictures which were made following routine cystic duct drainage.

serves) or safety valve, does not necessarily prevent the pathological end results of partial obstruction and the production of symptoms. (Fig. 6.) In this patient partial obstruction did not produce colic or jaundice, but it did produce a moderate degree of symptom-producing hydrohepatosis. The pathological condition resulting from intermittent or partial obstruction is concerned principally with the distended biliary radicals. These produce a pressure necrosis of the hepatic cells and a partial loss of the blood supply also due to pres-

sure, both of which predispose to the resulting fibrosis. Thus begins the early stages of biliary cirrhosis.

Inflammatory disease is the only principal etiological factor of stricture other than trauma. It is usually associated with calculus but may appear alone. When this occurs it is often by direct extension through the cystic duct. Hence the advisability of removing as much of a diseased cystic duct as can safely be done. The inflammation produces an obliterating or sclerosing choledochitis. Inflammatory stricture appearing without calculus disease and not associated with cystic duct inflammation is usually found in the distal end of the common duct and is almost surely associated with chronic pancreatitis, of which it is part. (Fig. 5.)

Figures 1, 2 and 3 illustrate clearly how easy it may be to injure the common duct during cholecystectomy. In Figures 1 and 2 the pouch is lying on and compressing the common duct. A clamp, or scissors, or tie, could easily seriously injure the latter. The pictures also show a short, narrow and twisted cystic duct which is a very real cause of non-calculus colic. In Figure 3 a long, convoluted, cystic duct can be seen passing under the common duct, and in such a case if the cystic duct is "pulled up" into the operative field, i.e., if the duct is brought to the operator rather than the operator going to the duct, the common duct must necessarily be brought to the clamp before the end of the cystic duct. These are practical examples of several of the causes of traumatic stricture and they prove that this is not a theoretical possibility. Another common cause is the promiscuous clamping of tissue holding a large or small bleeding point. This might grasp not only the common duct but also the right hepatic artery, even if it is in its normal position, and it is often anomalous as is the cystic artery. If the common duct cannot be visualized, it is better to leave behind some bladder wall, just as it is wise to leave part of an ovarian cyst, or part of an inflammatory mass, attached to

bowel wall rather than risk injury to the bowel.

*Partial obstruction of the common bile duct or duodenum*, or any interference with their motility may occur if the gallbladder fossa is not thoroughly peritonealized and an adherence occurs. (Fig. 9.) Indeed, it is a potential complication even after the most meticulous care has been given to the bladder bed and the hepatoduodenal ligament. Kinking of any segment of either may produce obstructive symptoms of varying severity; it may on occasion even resemble biliary colic. Adhesions may also interfere with the normal function of the pylorus. This is one of the few occasions in abdominal surgery in which the relief of adhesions will give relief of symptoms. Its successful prevention at the first operation or its successful treatment at the second operation will be almost assured by the use of the free omental graft. Recently sodium ricinoleate and lanolin-boric acid paste have been found very useful in the prevention of adhesions. The minimum of trauma (gentle and careful technic) is of course absolutely necessary. The writer recently operated upon a woman, seventy-three years of age, who showed two distinct fibrous bands across the common duct, (one across the common bile duct and one across the common hepatic duct). These were released but pictures were not obtained because the patient pulled the tube out on the second postoperative day. Since then all tubes have been anchored to the skin and the tube partially constricted by the tie. This also prevents an accidental withdrawal which has been known to cause very unfortunate complications.

*Functional changes* are often forgotten. All postoperative complaints are not necessarily due to organic disease. The former may produce symptoms even though extensive pathological conditions were found at operation. However, the majority of postoperative symptoms are organic in origin, especially if they appear late. Functional disease in the biliary tract is

beginning to assume the important place in diagnosis to which it is entitled. The discovery of, and the satisfactory treatment of these conditions is of the utmost importance, before operation as well as after, but particularly before. Early post-operative symptoms may be due entirely to an increased intraductal pressure which is usually produced by a reflex spastic sphincter, the result of cholecystectomy. Symptoms resulting from such an increase in ductal pressure are not constant and do not usually persist. On the other hand, the increased pressure or the spastic sphincter may be related to changes in the normal neuromuscular control of the pylorus or the sphincter of Oddi, which is a separate unit, and these symptoms are more likely to persist, especially if the patient is of the nervous, high-strung or irritable type. They will often respond satisfactorily to sedatives, rest, and antispasmodics, and are most often found in the long, lean, thin and flat (asthenic) patient. They are part of the real functional diathesis.

Tonic or spastic contraction of the outlet of the ductal system can produce complete obstruction to the bile flow with the associated clinical evidence of colic, jaundice and vomiting which so often accompany calculus or inflammatory obstruction. Chills and fever are, however, usually absent but low grades of fever may appear.

The rôle of the duodenum in producing symptoms, both before and after operation is not thoroughly understood, but workers at the Mayo Clinic (McGowan, Walters, Snell, Butsch, Knepper, etc.) have shown that it plays a very important rôle. They found that if the colic is the result of obstruction of the terminal section of the common duct, particularly of the sphincter mechanism, an increased duodenal pressure is always present, and that it is probably the producer of the former although the exact cause and effect relationship is not definitely known. However, even though the effect of the sphincter and the duodenum may be the same to

intrinsic simulae, their reaction to drug stimulation may be entirely independent.

The status of functional disease is difficult to define, and it is always hard to evaluate. There is no area of the body in which functional changes (neuromuscular imbalance) are more common than in the right upper quadrant of the abdomen. This applies to all patients whether or not they are in the "constitutional inferiority" group. The problem offers an enormous field for investigation. Antispasmodics (amyl nitrate and nitroglycerin for immediate use, and neurotrasentin and trasentin for prolonged use) often influence functional pain; they either reduce it or completely relieve it and never increase it as morphine might.

Figure 4 illustrates another functional item—a short, twisted, narrow cystic duct. Ivy names this in his list of causes of functional disease. The mechanism is probably as follows, although I have never heard this theory proposed before: The sphincter of Oddi and/or duodenal resistance becomes increased, due to any one of many potential causes, thus forcing the bile into the bladder. The liver secretes up to approximately 300 mm. water and the cystic duct sphincter opens at about 75 to 100 mm. water. Both these pressures are much below the potential Oddi resistance which I have measured as high as 800 mm. normal saline. It is thus easy to see that the bladder can, under certain, and maybe many, circumstances become quite dilated, and the bladder must necessarily pull on, tug against or even compress the cystic duct. This has little effect on a normal wide duct but it probably interferes with, and retards, the flow of a duct such as this picture shows. Therefore, varying degrees of cystic duct obstruction are produced which may be capable of causing pain as severe as that produced by calculus obstruction, particularly if the mucosal secretion is hyperactive.

Ivy also lists reverse duodenal peristalsis as another cause of functional (non-organic) complaints either pre- or postoperatively.

This can easily be seen when performing fluoroscopic cholangiography. Figures 1 and 2 are photographic proof. In Figure 1 the dye has been propelled in a reverse direction (cephalward) and in Figure 2 after more diodrast has entered the duodenum practically none appears distal to the ampulla while almost the entire ascending duodenum is filled. I have seen the bulb, and even the pyloric antrum, fill before any presses distalward. However, the clinical diagnosis of this condition as a cause of postcholecystectomy symptoms is not so easy as the x-ray demonstration.

*Lack of, or indifference to, medical treatment* is a common cause of postoperative symptoms. Indigestion or severe colic may result if a proper diet is not followed post-operatively. Medical treatment must not be neglected just because an operation has been made, and although the best results are immediately postoperative, the diet must be watched continuously, maybe for life.

*Traumatic Neuroma.* Neuromas appearing in the operative scar may occur following any incisional operation and they produce pain in the operative scar tissue. Physical examination should determine whether the pain is in or under the abdominal wall. Contraction of the abdominal muscles (by raising the feet and straight legs six inches off the floor) prevents the hand touching or pressing against the abdominal viscera, and therefore, if tenderness or pain persists under these conditions, it is strong evidence that the cause of the tenderness is in the abdominal wall and not under the protecting muscles. In addition, scar pain is not dyspeptic in nature and tenderness can always be localized to one small area in the scar. Local infiltration of the scar, or of the intercostal sensory nerve supply, will remove the pain if it is in the scar and thus prove the diagnosis. If the pain is severe, or persistent and debilitating, surgical removal may be indicated.

*Malignancy.* Cancer of the biliary tract is not uncommon. It constitutes 5 to 10

per cent of abdominal malignancies, and should always be considered both pre- and postoperatively. It is not an uncommon cause of postcholecystectomy complaints. Diagnosis is possible, though not probable, before the classical picture is presented. Indeed the diagnosis may be "missed" even when the abdomen is open, and because malignancy is not always diagnosed in the gross on the operating table, its supposed absence at operation does not prove that carcinoma is not the cause of postoperative symptoms. Indeed, if the causes as enumerated above can be ruled out, malignancy must be considered as the most probable cause.

All gallbladders examined pathologically should have multiple sections cut and each one thoroughly examined. Malignant changes are seen earliest near the fundus and near the cystic duct although they can occur in any area. The liver is involved usually early and jaundice is present soon after, due partly to liver involvement and due partly to enlarged glandular pressure on the hepatic or common ducts.

#### COMMENT

Symptoms following cholecystectomy are not given the serious attention that is their due either before, during, or after operation. Their preoperative consideration is, of course, of primary importance. The correct diagnosis of postoperative complaints should not be difficult; their treatment may be much more so.

The subject is one of the most important in biliary disease. Chief of the factors responsible for this are the frequency of a wrong or incomplete diagnosis which predisposes to inadequate treatment and to a continued and preventable invalidism, a lack of appreciation of the progressiveness of biliary disease, a lack of understanding of the basic biliary disorder, and surgical inexperience. It is an unfortunate but correctable state, that so many serious

factors should be associated with the second most common operation performed in general practice.

The incidence of these unhappy results can be, and should be, reduced.

#### SUMMARY

The subject of postcholecystectomy symptoms is discussed generally and briefly under the headings of the principal etiological factors. These are: (1) wrong diagnosis, (2) residual disease, (3) common duct calculi, (4) common duct stricture, (5) partial obstruction of the duodenum or ductal system, (6) functional changes, (7) lack of, or indifference to, medical treatment, (8) traumatic neuroma in the wound, and (9) malignancy.

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# PERIPHERAL ARTERIAL EMBOLISM

## BRACHIAL EMBOLISM SUCCESSFULLY TREATED

ROBERT D. DUNCAN, M.D.

Surgical Staff, U. S. Marine Hospital

AND

MARK E. MYERS, M.D.

Surgical Staff, U. S. Marine Hospital

BALTIMORE, MARYLAND

PERIPHERAL embolism is a condition that carries with it a high rate of mortality and a low rate of cure. The fault is not always with the surgeon or medical man, as a great many of these patients seek a physician's advice or are seen too late for curative therapy. This can be understood when it is realized that a lapse of ten to twelve hours from the onset of the disease and the initiation of treatment is enough to defeat all efforts at cure in a large percentage of cases. In one instance, a cure has been reported after seventeen hours.<sup>1</sup> However, it is true that in a large number of cases the therapy has been delayed beyond the period of possibility of recovery by a course of conservative management or by the lack of recognition, or by the lack of realization of the necessity for emergency treatment by the attending physician.<sup>2,3</sup> Brachial embolism gives a better prognosis than embolism in other localities but still carries with it a percentage of failure in the neighborhood of 60 per cent or more.<sup>4,5,6</sup> A case of peripheral embolism must be handled rapidly and for this reason it was believed that the report of a successful case and summary of the present methods of treatment together with a review of the recent literature would be of value.

The Scandinavian surgeons were the first to take up the surgical treatment of peripheral embolism, the first successful case being done by Key about 1911. The first successful case in England was in 1925.<sup>1</sup> Strombeck,<sup>7</sup> Key,<sup>8</sup> Nystrom,<sup>9</sup> de Takats,<sup>4</sup> Cornell,<sup>3</sup> and Pearse,<sup>10</sup> have reported on large series of cases in recent years.

The cause of arterial embolism has been

described as a triad composed of heart disease, arterial disease and an additional factor acting as an insult to one of these conditions. The patients are often in poor general condition, and there is often an associated decompensation and dehydration present. This results in the slowing of the peripheral blood flow and adds to the danger of propagation of the clot from the embolus, and also increases the possibilities of a postoperative thrombosis.

The diagnosis of peripheral embolism is comparatively simple. The problem is to see the patient within the prescribed time limit so that effective therapy can be instituted. The usual symptomatology is described as a localized, sudden, agonizing pain in a limb, with tenderness over the point of lodgement of the embolus. Pulsations are absent and the limb is cold, white and paralyzed. The usual symptoms and signs may be of a more insidious nature if the embolus begins in one of the smaller arterial branches. The progression of the clot together with the gradual shutting off of the circulation may mask the diagnosis and may be almost painless in its earlier stages. It is this type of patient who is a challenge to early diagnosis or who may come too late for effective treatment. It has been shown that emboli more commonly lodge at the arterial bifurcations in certain areas. These areas are in order: the femoral artery (44 per cent); iliac artery (19 per cent); brachial (17 per cent); bifurcation of the aorta (10 per cent); and the popliteal (10 per cent). Arteriography and the histamine flare have been advocated for localization of the embolus but are limited in usefulness. The use of the oscilloscope or ordinary blood pressure cuff

may be of considerable aid. The diagnosis as to the actual localization of the clot cannot be depended upon entirely and is sometimes made difficult preoperatively due to the propagation of the clot up or down the artery. The associated vasoconstriction may make it difficult to determine the site of obstruction.

The main point of importance in the differential diagnosis is to distinguish this condition from thrombosis which may occur from arteriosclerotic changes, inflammation, Buerger's disease and trauma. The condition in its early stages may have to be differentiated from hemiplegia. If a mistake in diagnosis is made and a thrombus is present rather than an embolus, local surgery is of no value.

The prognosis in general in patients with peripheral embolism is poor. Key<sup>8</sup> has reported an average of 38 per cent cures; Lund has reported 37 per cent operative cures. In breaking down the cases according to their location, it has been said that restoration of circulation may be expected as follows if the patient is seen early enough to warrant surgery: brachial artery 44 per cent; femoral 20 per cent; popliteal 20 per cent; aorta 17 per cent; iliac 15 per cent. Nystrom in 382 cases of embolectomy reported that 60 per cent of the patients died, 20 per cent had to have amputations and 20 per cent left the hospital with good circulation.

#### TREATMENT

The treatment in peripheral embolism is designed to combat the major pathological changes that occur. Thus it must take care of the embolus and the resulting loss of circulation, it must counteract the marked vasoconstriction and resulting interference with collateral circulation, and it must, if possible, limit any further extension or propagation of the clot either up or down the artery.

Conservative or nonoperative therapy versus operative treatment must be decided upon. In most instances the decision must be made immediately because of the time

factor involved. If removal of the embolic clot is to be of any value, it must be done early before any organization, thrombosis or adherence to the intima of this artery has occurred. Any such changes inevitably result in postoperative thrombosis. A number of spontaneous cures and cures on conservative therapy have been reported, but in most instances only the terminal arterial branches have been involved or the block has been incomplete. Lund states that under conservative therapy there have been 10 per cent cures. In other reports, the mortality has varied from 87 per cent to 100 per cent. In a few instances in which patients are seen immediately following the embolic phenomena, it may be desirable to try conservative therapy. The time for a trial, however, must be very short, and even after a period of trial it is usually very difficult to determine whether to keep on or resort to surgery. For this reason, operation is believed to be the method of choice.

Conservative therapy with its many measures may well be combined with operative intervention. The use of a well outlined course of conservative treatment preliminary to and while preparation for surgery is being made, may be the deciding factor as to a surgical cure or failure. These measures include sympathetic injection, the use of aids to the collateral circulation such as the pavex boot, intermittent venous occlusion, indirect heat, and papaverine in half-grain doses intravenously, and the use of heparin to limit the process and prevent propagation of the clot. In considering the conservative measures, it might be mentioned that we favor injection of the sympathetics with procaine followed by 95 per cent alcohol, because of the prolonged and, in some instances, seemingly more intense response following alcohol. The injections with alcohol if made properly should cause no trouble, and in any event the changes are not permanent.

The surgical measures include embolectomy,<sup>12</sup> concomitant vein ligation and amputation. Embolectomy is indicated

under the following circumstances: (1) When the condition is certainly not over twenty-four, preferably not over ten, hours old; (2) when the medical condition does not preclude all possibility of surgery and there are no multiple emboli; (3) when there has been a lack of improvement or a progression under conservative treatment. If there is marked arteriosclerosis present and the condition is ten to twelve hours old or longer, or if there is an associated peripheral vascular disease or inflammation, surgery will probably be useless because of recurrent thrombosis.

#### TECHNIC OF EMBOLECTOMY<sup>4,13</sup>

The preoperative preparation should include paravertebral sympathetic block with procaine and alcohol. Papaverine, half-grain, may be given along with the desired preoperative medication.

The operation may be carried out under local (without epinephrin), pentothal or general anesthesia. A wide incisional approach is made. When the site of the embolus is reached, rubber bands, tapes, or artery clamps are placed above and below the clot, the proximal one being to control hemorrhage and the distal one to prevent further peripheral dislodgement of the clot. Throughout the operation the tissues are kept moist with normal saline, Ringer's, or 2 per cent citrate solution. The tissues must be handled gently and trauma to them avoided as far as is possible if post-operative thrombosis is to be avoided. If the clot is seen to extend down into the bifurcating branches of the artery, a small longitudinal incision may be made into the artery just above the bifurcation and, with the rubber bands or tapes held tightly, the inferior portion of the clot may be carefully removed with a forceps or by suction. Another band is then placed above the bifurcation and is held tightly. The proximal tape is then loosened and the remainder of the clot, if small, may be extruded by the pressure of the blood. In most instances the clot must be milked out with the fingers, or can be removed by a combina-

tion of milking and suction. A small, soft, lubricated catheter introduced into the vessel may be a convenient way of applying suction. A spurt of blood, which is immediately controlled by the upper band or tape, then tells one that the obstruction has been cleared. The Carrel technic of arterial suture using fine, waxed, black silk, either interrupted or continuous suture is then applied and the opening in the artery is closed. Bleeding between the sutures is sometimes bothersome and can be controlled by applying steady light pressure with moist gauze over the line of suture for a few minutes. Careful asepsis must be carried out and trauma to the tissues and particularly the intima of the artery must be avoided if postoperative thrombosis is to be prevented. The sites of lodgement of emboli are of ready accessibility except for those of the aorta and iliac vessels. The latter are probably more easily approached in an extraperitoneal manner.

Postoperatively heparinization is started. This may be started immediately or within a few hours. Heparinization<sup>4,14,15</sup> may be done in a number of ways. Fifty mg. of heparin may be given at the start of an infusion and then enough heparin may be added to the infusion bottle to give the patient approximately 50 mg. every four hours. The coagulation time should be tested every hour and maintained at about fifteen minutes by the capillary method. This infusion may be continued for the first twenty-four hours after which heparin is given in 50 mg. doses, or whereabouts, every four hours during the day, with 100 mg. being given to carry through the night. Heparinization is continued one week and then slowly discontinued. The use of intravenous solutions and blood pressure stimulants may aid in maintaining a forceful circulation if the patient's general condition permits this.

Arterectomy of the involved segment should be done if at operation the clot is organized and adherent to the walls of the artery, or if rather than embolism a thrombosis is seen to be the underlying

pathological change. Concomitant vein ligation is also advocated under such circumstances.

Amputation may be necessary if the case is seen too late for surgery, and an adequate trial with sympathetic block, pavex, indirect heat and papaverine does not relieve the cyanosis, mottling, paralysis and coldness of the limb. The histamine flare test and a study of the patient will reveal the necessity of amputation, which should be done before complications arise. There are definite sites of amputation according to the level of occlusion. Aortic emboli require amputation three or four inches below the hip joint. Iliac emboli require midthigh amputation. Femoral emboli require amputation above the knee. In popliteal occlusion amputation must be done at the junction of the upper and middle thirds of the lower part of the leg. In the upper extremity emboli of the brachial artery requires amputation at the upper third of the forearm, and axillary emboli require amputation at or just above the elbow.

The axillary and brachial arteries when involved by an embolus give the highest percentage of cures presumably due to the more profuse collateral anastomoses. However, if the collateral circulation of the upper part of the arm and of the femoral and iliac regions is compared, very little difference is seen, and if anything the difference is in favor of the latter. We believe that the reason the results of embolectomy of the upper arm are more satisfactory is that they are seen earlier. A loss of function of the upper arm is more easily noticed particularly if the patient is in bed, and also disturbs the patient much more than interference with a leg. The patient we are discussing was seen early and was operated upon between six and eight hours after the onset of his embolic phenomenon. At the time of operation it was interesting to note the propagation of the clot in the vessel during the exposure of the artery, the clot extending about one and one-half inches proximally while under observation.

The clot at operation measured eight inches in length and completely occluded the collateral arterial vessels, as shown in the case report. We are certain that amputation would have been required. This patient did not receive heparin because his immediate postoperative course was so satisfactory with a bounding radial pulse, and because none was available at the time. The patient had a "water-hammer" type pulse which may have aided the recovery.

#### CASE REPORT

F. H., male, age fifty-one years, was admitted to the hospital on August 28, 1941. The patient entered the hospital for the treatment of a chronic left leg ulcer of two months' duration. He had been in the hospital several times previously and diagnoses of aortic insufficiency and regurgitation, syphilitic aortitis, and generalized arteriosclerosis had been made. While in the hospital the patient was found to have a low cardiac reserve and had several periods of decompensation. On November 27, 1941, he developed bronchopneumonia from which he recovered satisfactorily. On December 11, 1941, he developed sudden pain, coldness and partial paralysis of the lower two-thirds of the right leg and foot. A diagnosis of arterial embolism was made. The lumbar sympathetics were injected with procaine and alcohol; he was given heat to the lower part of the body and to the leg, and pavex therapy was started. His response was good and recovery was complete in one week. The patient's cardiac condition remained poor, however, and he continued under treatment for this.

On February 14, 1942, he was seen in the morning and was complaining of pain and paralysis of the right arm of about an hour's duration. The arm was seen to be cold and pale with the hand and fingers drawn up in a contracted position, and with loss of motor power and sensation below the elbow. Radial and ulnar pulsations were absent. A diagnosis of brachial embolism was made and the patient was taken to surgery.

At operation a long incision was made over the artery extending from the first portion down over the branching portions of the artery. The median nerve was dissected free and retracted out of the way. The

antecubital fascia and the biceps tendon were cut, thus exposing the bifurcation of the brachial artery at the elbow. On exposing the complete artery, the clot within the vessel could easily be seen. The clot completely filled the brachial artery and extended about one inch down into the radial and ulnar arteries. The entire brachial artery was occluded as was the profunda brachiae and all of the collateral branches including the radial and ulnar recurrent vessels. The various branches of the artery in the upper part of the arm were ligated. Rubber bands were placed above and below the embolus. A small incision about one inch long was made just above the bifurcation of the artery, and the extensions of the clot into the radial and ulnar arteries were removed with a forceps. The remainder of the clot in the brachial artery was removed by a combination of suction and milking. A small, soft rubber catheter lubricated with vaseline was introduced into the artery as a means of suction, and the milking action was carried out with the hand. The small arterial incision was then closed with interrupted, waxed, black silk sutures.

Immediately postoperatively the radial pulse at the wrist returned to normal. The ulnar pulse was not palpable. The arm returned gradually to normal and four days later the patient was seen using his right hand to eat with. He was discharged from the hospital on March 24, 1942.

#### SUMMARY

1. The recent literature on peripheral embolism has been reviewed with statistics on various methods and results in treatment.

2. The technical details of the treatment of this condition have been outlined and discussed.

3. A case report of a patient showing complete brachial arterial occlusion has been presented. This patient was successfully treated.

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# ACUTE GASTRODUODENAL PERFORATIONS\*

REVIEW OF METROPOLITAN HOSPITAL SERIES 1930-1941

EDWARD J. McCABE, M.D. AND WALTER L. MERSHEIMER, M.D.  
NEW YORK, NEW YORK

IT is of interest to review a series of cases first to determine those methods that have produced the best results in a particular hospital and second to compare these methods and results with similar series in other hospitals. Then by critical analysis faults may be corrected and a future course plotted.

Many interesting theories have been advanced to explain the pathogenesis of ulcer. There is rather conclusive evidence that peptic ulcer does not occur in patients with complete and persistent achlorhydria.<sup>1</sup> Whether there is stagnation of gastric contents permitting accumulation of highly acid material,<sup>2</sup> or hypersecretion of abnormal neurogenic origin,<sup>3</sup> the defensive mechanism is broken down and peptic ulcer results. Actual destruction of the tissue results from the proteolytic gastric juice both the hydrochloric acid and the pepsin.<sup>4</sup>

As the factors causing peptic ulcer continue to act the depth of the ulcer increases and the ease of perforation is facilitated. When intragastric pressure exceeds intra-abdominal pressure, perforation occurs.<sup>2</sup> Recent ingestion of a heavy meal or liquids, sudden straining or lifting may precipitate the acute episode.

The number of perforated peptic ulcers admitted to any one hospital is relatively small. The incidence to total number of admissions is about .001 per cent. During an eleven-year period (1930-1941) at the Metropolitan Hospital there were eighty-nine perforated peptic ulcers; total hospital admissions for the same period were about 132,000; or an incidence of .0006 per cent.

In nearly 5,000 consecutive gastrointestinal series, 883 peptic ulcers were found;

78 per cent were duodenal and 22 per cent were gastric.<sup>5</sup>

Perforation is the most deadly complication of peptic ulcer. As Cope<sup>7</sup> has stated "delay or missed diagnosis is equivalent to a death sentence from which there is little chance of reprieve." The onset is spectacular and it belongs to the group of abdominal catastrophies. The previous history is definitely suggestive of ulcer in over two-thirds of the cases; the remaining one-third may give no history suggestive of ulcer. Of the patients admitted to the Metropolitan Hospital thirty-four gave a definite history of ulcer history and twenty-nine a history highly suggestive of ulcer. Ten of these sixty-three perforated while under treatment in the hospital. Perforation occurs most frequently in the white male. In the present series eighty-two were white males; two colored males; one white female and two colored females. Jennings<sup>8</sup> has recently surveyed the age incidence and sex distribution and concludes that prior to 1900 three of every six perforations occurred in women under twenty-five, one in an elderly woman, one in an elderly man, and one in a young man. Since 1920 he has found nine of every ten occur in a middle-aged or young man and one in ten in an elderly woman. Garver<sup>9</sup> reported forty-three perforations in negroes and concludes as does Odom and DeBakey that the incidence in the colored and white race is about equal. The age is usually between twenty and fifty, the average age in the present series slightly over forty-five years. Not included in this series was an eleven months old male infant successfully operated upon for a perforated peptic ulcer at

\* From the Department of Surgery, Dr. L. R. Kaufman, Director, New York Medical College, Flower and Fifth Avenue Hospitals and Metropolitan Hospital.

the Metropolitan Hospital. Perforation has been successfully operated upon less than forty-eight hours after birth and peptic ulcer has been known to occur even in utero.<sup>11</sup> To the other extreme one of our patients was seventy-seven years of age and made a satisfactory recovery.

The story of the present illness leads one to suspect the diagnosis in nearly every case. The patient may state that shortly after the ingestion of a meal or liquids, while lifting or straining he was suddenly and violently seized with an agonizing pain. The pain may be described as burning, lancinating, or knife-like. It frequently starts in the epigastric region and rapidly spreads throughout the abdomen, particularly if located on the anterior surface near the pylorus. When the perforation is on the anterior surface of the duodenum fluid gravitates to the right lower quadrant and this pain may be confused with that of acute appendicitis. Perforation through the posterior gastric wall into the lesser sac occurs infrequently, but this pain may simulate the colicky pain of intestinal obstruction. Perforated gastrojejunal ulcers and perforations on the lesser curvature may give rise to predominantly left-sided symptoms. Shoulder pain, either right or left shoulder or both shoulders is highly suggestive. Nausea is frequently present and vomiting in a fewer number. The patient may "double up" following the onset, he may fall to the floor; rarely does he faint. Activity becomes greatly limited. The patient is "afraid to move" as it greatly aggravates the pain.<sup>7,12,13,14</sup>

The patient frequently presents a typical facies and position. His expression is anxious and is drawn with pain. He may be covered with cold sweat. The respiration is shallow and of costal type. Often he lies motionless on his side or back with knees drawn up and hands clutched to the abdomen. The scaphoid abdomen is frequently observed. When the abdomen is palpated the outstanding feature is the board-like rigidity. Occasionally, this may be most pronounced in the epigastrium, in-

frequently the right lower quadrant. Palpation elicits exquisite tenderness, rebound tenderness and skin hyperesthesia. Percussion for fluid in the flanks is of little value for early diagnosis of perforation. Demonstration of diminished liver dullness is pathognomonic of a ruptured viscus but unfortunately it cannot be elicited in every case. When looked for it was found in 50 per cent of the present series. There is exquisite rectal and vaginal tenderness. A metallic note just beneath the xiphoid is sometimes present. The abdomen is "silent" to auscultation. Chest sounds are amplified if considerable fluid is present and in some instances, synchronous with respiration, a friction rub may be heard. Temperature and pulse are of some diagnostic value. Temperature is normal or subnormal in the early stages but later when generalized peritonitis supervenes it is elevated. The pulse may be little altered, occasionally rapid when shock or advanced peritonitis is present. Leucocytosis occurs early, counts ranging between twelve and sixteen thousand were most frequently recorded and there was a shift to the left. The presence of subdiaphragmatic air as shown by the roentgenogram is pathognomonic of a ruptured viscus, and it is stated that when the plate is taken with the patient in the left lateral position air will be more frequently demonstrated.<sup>15</sup> It has also been stated that subdiaphragmatic air is more frequently found following perforation of duodenal than gastric ulcer.<sup>16</sup> It has been reported as high as in 95 per cent of the patients examined.<sup>17</sup> We have been unfortunate in that we could demonstrate subdiaphragmatic air in but about 50 per cent of the patients examined. However, we do not hold with those who believe it is unnecessary to waste time with the x-ray hunting for air under the diaphragm.<sup>17,18</sup> When air is not demonstrated beneath the diaphragm it has been suggested that a stomach tube be passed and 20 or 30 cc. of air be injected and a second roentgenogram made. Undoubtedly, this

will increase the percentage of positive plates.<sup>10</sup>

When the roentgenogram fails to show the presence of subdiaphragmatic air it is imperative that blood be drawn and an estimation made for serum amylase. If this principle is adhered to relatively few patients with acute edematous or hemorrhagic pancreatitis will be erroneously operated upon for a perforated ulcer. Elman<sup>20</sup> has emphasized the value of amylase determinations and its value in detecting acute pancreatitis. During the past two years estimation of the serum amylase has been done in every case in which we have failed to find subdiaphragmatic air, and in several we have been enabled to establish the diagnosis of acute pancreatitis. Furthermore, it has been our good fortune not to operate a single patient with a preoperative diagnosis of perforated peptic ulcer and find an acute pancreatitis. Lewison<sup>21</sup> analyzed the results of 1,500 serum amylase determinations. His work serves to confirm the conclusions of others. He found deviation from normal infrequent in any other than acute pancreatitis. There was a prompt and significant rise in acute pancreatitis reaching a peak within forty-eight hours. Patients with mumps had elevated serum amylase; those with hepatic disease depressed.

When the roentgenogram fails to prove the presence of a ruptured viscus and the serum amylase is normal, peritoneal tap and aspiration should be performed. Peritoneal aspiration is diagnostic and relatively devoid of danger.<sup>22-25</sup> The puncture is performed in both right upper and right lower quadrants of the abdomen using a spinal needle and syringe. The fluid aspirated is examined grossly and microscopically. Steinberg<sup>22</sup> has described the diagnostic features. He emphasizes that when peritonitis is due to a perforated peptic ulcer under twelve hours' duration mucinous material, bacteria and cholesterol crystals will be present. In the late cases, that is over twelve hours, fiber shreds and cholesterol crystals are seen. Five to 10

per cent of cells present are eosinophilic polymorphonuclears.

Diagnosis of ruptured viscus may be facilitated by giving the patient 30 to 50 cc. of a dilute methylene blue solution by mouth or introduction through a Levin tube one-half hour prior to peritoneal aspiration. Recovery of the dye is an absolute indication that perforation exists and at time of celiotomy will assist in locating the site of perforation. We have not failed to aspirate the dye in a single case in which perforation existed. The procedure is simple and without danger, and it may be done at the bedside, and it is not costly or time consuming.

A correct diagnosis should be made in nearly ever case. During the past two years we have missed the diagnosis in but a single instance, incorrectly diagnosing an acute appendicitis. We regret that x-rays failed to show subdiaphragmatic air and we neglected to perform an abdominal paracentesis. During the eleven year period correct diagnosis was made in 89.7 per cent of the cases, the diagnosis missed in 10.3 per cent. A diagnosis of acute appendicitis was made in eight instances and intestinal obstruction in one. Diseases to be considered in the differential diagnosis are:<sup>5-14</sup> (1) Acute appendicitis (ruptured pelvic abscess); (2) acute mechanical intestinal obstruction; (3) acute pancreatitis; (4) acute cholecystitis and cholelithiasis; (5) ruptured ectopic pregnancy; (6) renal colic; (7) gastric crisis of Tabes; (8) acute toxic gastritis; (9) coronary occlusion; (10) diaphragmatic pleurisy, and (11) pneumonia.

The presence of "shock" is frequently recorded in the typical description of a perforated peptic ulcer. Soutter,<sup>21</sup> reviewing a large series at Bellevue Hospital, concluded that true shock occurred in only 6 per cent of the patients and when present a second factor, most often peritonitis, was present. Shock was definitely present in 10 per cent of our patients (nine of eighty-seven). It should be emphasized that six of these nine patients

expired in spite of vigorous therapy to combat shock.

There is a clinical axiom that a "bleeding ulcer does not perforate and a perforated ulcer does not bleed." This has been refuted. Winters<sup>27</sup> and his associates report that Finister saw but three patients with hemorrhage and perforation. In their review of 361 patients bleeding was present in 10 per cent of patients with perforated peptic ulcer. Our experience confirms that bleeding and perforation occurs more frequently than is generally conceded. Hematemesis or melena occurred in about 15 per cent of the patients within twenty-four hours of operation for perforation.

The time elapsing between perforation and operation has been stressed, and it is asserted that the lower mortality rates are associated with the shorter time intervals.<sup>10, 17, 18, 28, 29, 30, 31</sup> The average time elapsing between perforation and admission to the hospital in all our cases was 8.48 hours, the time between perforation and operation 11.09 hours. In the patients who expired the time elapse between perforation and operation was over twenty-one hours.

The preoperative preparation is varied but slightly. When the diagnosis is established a Levin tube is passed and continuous siphonage maintained with the Wangensteen<sup>32</sup> suction-siphonage system or the Furniss motor pump<sup>33</sup> preoperatively, throughout the operation, and during the postoperative phase. Blood is obtained for typing and cross-matching, and when indicated to combat shock or dehydration intravenous fluids are given preoperatively. Preoperative medication and choice of anesthesia is dependent on the Department of Anesthesiology. Most frequently morphine and hyoscine is given intravenously, as soon as the diagnosis is established to combat shock and because of the short time elapsing between decision to operate and time of operation. Inhalation anesthesia; usually cyclopropane and oxygen, less frequently nitrous oxide-ether and oxygen has been given in over 80 per

cent of the cases. Spinal anesthesia or novocaine field block was used in the remainder. It is our opinion that spinal anesthesia is to be preferred, mainly for the excellent relaxation offered. Mortality and morbidity rates vary little between inhalation and spinal anesthesia. Odom and DeBakey report lower mortality rates with spinal than with inhalation anesthesia.<sup>10</sup>

The majority of surgeons do not favor radical operation for the acutely perforated ulcer.<sup>5, 10, 17, 18, 28-30, 34-39</sup> As Lahey<sup>37</sup> has stated, "when operating on a patient with perforation of a duodenal ulcer the primary duty of the surgeon is to save his life and not attempt to cure his ulcer at the same time." Our experience dictates that simple plication of the perforation, with or without reinforcement with an omental tag, and no drainage is the only indicated operative procedure. Forty-eight patients had simple plication, the mortality was 22.4 per cent. This compares favorably with similar series but is nearly three times the mortality as reported by Hook<sup>33</sup> and twice that of Fallis.<sup>36</sup>

The operative technic has been frequently discussed but there are several points worthy of reiteration. The incision should be a small (not over 6 cm. in length) supraumbilical right rectus incision, splitting the rectus muscle at the junction of its middle and medial one-third. As soon as the peritoneum is opened culture of its contents should be taken and all excess peritoneal fluid gently suctioned off. The stomach should be lightly grasped protecting it with a warm laparotomy pad and the point of perforation determined. This will be facilitated if the patient has been previously given a few cubic centimeters of a dilute methylene blue solution orally or through a Levin tube. Plication should proceed with definite routine. Interrupted Lembert No. 00 or No. 000 chromic sutures on an atraumatic needle should be placed. The sutures should be placed in the long axis of the gastrointestinal tract to plicate the perforation transversely to the

long axis to avoid further stenosis of the pylorus. A deeper bite, and further from the point of perforation, should be taken on the gastric than on the duodenal side. Three or four such sutures will suffice but the operator may reinforce this with a second row of interrupted or continuous Lembert sutures. As a further safeguard gastrohepatic or gastrocolic omentum may be "tacked" to the suture line. Occasionally, a "callous" ulcer with perforation so large as to defy simple plication is encountered. These may be covered with omentum after the plan of Neuman or triangular excision and approximation according to the Heincke-Mikulicz principle as advocated by Odom and DeBakey.<sup>10</sup> Based on experimental studies Serebrennikoff and Snezhkoff<sup>40</sup> favor the turning of a seromuscular flap for occlusion of the perforation. They state that omentum succumbs readily to infection and frequently undergoes cicatricial degeneration. Using the seromuscular flap they found that complete regeneration of the mucosa within the former area of the perforation occurred in forty-five days. This method should be kept in mind when large perforations are present and when there is difficulty closing a perforated "callous" ulcer.

During the past two years the practice of draining the peritoneal cavity for perforated peptic ulcer has been abandoned at this hospital. Twenty-one patients of the present series had one or more drains, most frequently of the Penrose type placed to the site of perforation or into the right subhepatic pouch. The mortality in this group was 31.8 per cent. We believe drainage is indicated in a perforated peptic ulcer only when a localized abscess is present.

The local implantation of sulfonamides into the peritoneal cavity at the side of perforation is probably not essential if the patient is operated upon within six hours of the time of perforation. Davison<sup>41</sup> has shown that cultures taken within this time limit are sterile. Organisms cultured after this period are most frequently the colon

bacillus and streptococcus. We have also encountered the staphylococcus and pneumococcus. Local sulfonamides were used in only five instances and three of these patients expired. This experience in no way parallels our results with sulfonamides in ruptured appendicitis.<sup>42</sup> Further observation is necessary, but at present we plan to continue the local use of 8 Gm. of sulfanilamide and 4 Gm. of sulfathiazole if perforation has been present for more than six hours.

The peritoneum and posterior rectus sheath is closed with a continuous suture of No. 0 chromic. Two or three dermal retention sutures are placed through all layers of the abdomen except the peritoneum and held with Davey buttons. The anterior rectus sheath is closed with interrupted No. 0 chromic and the skin closure accomplished with Michel clips. The wound is not drained. Because of the high incidence of wound complications it is now planned to close the abdomen in layers using interrupted Alloy wire sutures advocated by Kaufman<sup>43</sup> and Jones.<sup>44</sup>

Plication of the perforation combined with gastroenterostomy was the procedure of choice in five cases. There was one death. This compares favorably with results obtained by Ross and Letourneau.<sup>45</sup> The procedure has been abandoned during the past two years. Gastroenterostomy is usually done when the surgeon believes that pyloric stenosis is present to such a degree that pyloric obstruction will result and a second procedure will become necessary. This is very rarely the case. The use of a Levin tube and constant syphonage during the early postoperative period insures an empty stomach and permits the edema about the pylorus to subside and its patency to be reestablished. Rather than perform gastroenterostomy at time of perforation it would be better to thread an Abbot-Rawson or Levin tube through the pylorus for postoperative feeding. Neither do we believe that jejunostomy is indicated.

A second operative procedure such as appendectomy should never be performed. In the six cases in which the perforation was plicated and appendectomy performed three patients expired, a mortality of 50 per cent. It is far better, even when the diagnosis has been missed, and a McBurney incision made, to return the appendix intact and to repair the wound, making a second supra-umbilical right rectus incision to care for the primary pathological condition. Certainly, a degree of periappendicitis will be encountered but this is a small part of the generalized peritoneal reaction.

During recent years, subtotal gastric resection performed at time of operation for perforation has been advocated. It has been performed in selected cases and has yielded excellent results. According to Niess<sup>47</sup> the first gastric resection for perforated ulcer was performed by Von Haberer in 1929. He also reports that Yudin performed resection in 673 patients with a 9.8 per cent mortality, and in the last 121 cases the mortality was 6.6 per cent. He further states that Peters has a mortality of 7.6 per cent in one hundred cases. The mortality for the group having had resection for perforation at the Frankfurth Clinic was 6.7 per cent. Kirnman<sup>48</sup> performed thirty-five resections in a series of 137 cases of perforated ulcer. His mortality was 8.5 per cent. Neuffer<sup>49</sup> reports fifty-five patients with gastroduodenal rupture in which a Billroth II type resection was performed in forty-four cases with 13.6 per cent mortality. Morgottini<sup>50</sup> has performed primary gastric resection in fifty-four of sixty-six patients with perforation with a mortality of 14.8 per cent. Immediate resection was done by Balston<sup>52</sup> in fifty-nine patients of a series of 136 with a mortality of 8.4 per cent. Billroth I or the Von Haberer modification was used.

The results quoted above undoubtedly rank with the best that may be found in the literature. Naturally, the cases are selected. The case for resection should ful-

fill the following qualifications: The patient should preferably be under fifty years of age; general health should be good, particularly the state of circulation; the time elapsed since perforation should be relatively short, preferably less than six hours, the limit twelve hours; the extent of peritonitis must be estimated—with a small perforation there is less peritonitis than with a large perforation and a violent reaction, independent of the time interval; resection should not be performed in face of advanced peritonitis; the surgeon must be widely experienced in gastric surgery and not the "occasional" operator.

The postoperative care requires meticulous attention to details, which are frequently overlooked. The patient is most often placed in Fowler's position, but when there is danger of aspiration of secretions from the nasopharynx the patient is placed in Trendlenburg or prone position with the foot of the bed elevated to facilitate drainage from the upper respiratory tract until there is complete recovery from anesthesia. Morphine is given in adequate doses every four hours, occasionally by continuous drip along with the intravenous fluids. The Levin tube or Abbot-Rawson<sup>46</sup> is connected for continuous suction with either the Wangensteen<sup>32</sup> three-bottle system or the Furniss<sup>33</sup> motor suction system. Siphoning is continued without removal of the tube for a seventy-two hour period. When the Abbot-Rawson tube is utilized, jejunal feedings can be instituted six hours postoperatively. We prefer feeding by continuous drip method. When the Levin tube is used nothing is given by the oral route during the first twenty-four hours. During this period the patient receives 2,500 cc. by the parenteral route. Five per cent dextrose in physiological saline constituting the greater portion of the fluid, but whole blood or plasma is given when indicated by hematocrit readings. The best possible oral hygiene should be observed during the postoperative period, particularly when the patient is not receiving fluids by mouth and when there is danger of irritation re-

sulting from the tube. After twenty-four hours small amounts (15 cc. every one hour for twelve hours and then 30 cc. every one hour for twelve hours) of warm water are given orally, clamping off the tube for one half hour after administration. Ten cc. of physiological saline are instilled through the tube every hour to insure its patency. Again parenteral fluids are given during this period. After forty-eight hours the patient is placed on the modified Mayo regimen. The tube is removed after seventy-two hours. Frequent change of position, movement of the extremities, and forced inspiration every hour aid in avoiding post-operative complications. Chase<sup>53</sup> has reviewed the problem of anoxia and its surgical significance. Our patients are given high concentrations of oxygen controlled by the O. E. M. mask and oxygen is continued as long as there is danger of anoxia. When the patient fails to void within twelve hours, he should be catheterized. Bed rest is enforced for a ten-day period.

The perforation is most frequently cited as occurring on the anterior surface of the duodenum.<sup>5,31,34,33,45,54</sup> Anterior gastric perforation has also been reported more frequently than duodenal perforation.<sup>9,53</sup> In the present series there were ten gastric, forty-two prepyloric, ten pyloric, and twenty-five duodenal perforations. Doubtless, there is a considerable percentage of error in correctly diagnosing the site of perforation at the time of operation. This may be explained in part by destruction of landmarks by the pathological process at work and part by the hasty conclusion of the surgeon. The most frequent error is failure to recognize duodenal ulcer with perforation that has extended to include pyloric and prepyloric regions, incorrectly concluding that it is a gastric perforation.

The incidence of recurrent perforation is low.<sup>34,56-59</sup> Fobes<sup>56</sup> has recently reviewed the subject of recurrent perforations and has reported two of the cases that are included in the present series. In the present series two of our patients had second perforations. J. V. had an elapse of nine

months between the two episodes. During this interval the patient was closely observed and adhered to a strict medical regimen. Both perforations occurred while the patient was hospitalized for medical treatment of exacerbation of symptoms. At operation for the second perforation simultaneous gastric and duodenal perforations were observed. The patient made an uneventful recovery and later a subtotal gastric resection was performed. Simultaneous multiple perforations are not unknown.<sup>56,60-62</sup> Perforations have repeatedly been reported following gastroenterostomy.<sup>34,63-65</sup> There was but one in the present series which occurred two years following posterior gastroenterostomy. Perforations have been observed following subtotal gastric resection.<sup>32,56,66,67</sup> The following case is the only one under our observation:

A forty-one year old Puerto-Rican male had a history of ulcer since 1932. In 1934 a simple plication was performed for perforation. During the next six years the patient was hospitalized seven times for medical treatment of the ulcer. A subtotal gastric resection and anterior gastrojejunostomy (Pólya type) was performed in September, 1940, and the patient was discharged two weeks later. He remained asymptomatic for six weeks, and then was readmitted and a diagnosis of perforated marginal or jejunal ulcer was made and emergency operation performed. At operation perforation of the duodenal stump was found and simple plication performed. On the sixth postoperative day the patient violently removed his dressing, got out of bed and dehisced the upper one-half of the wound. Two days later a duodenal fistula developed. A severe hypoproteinemia occurred in spite of generous transfusions of plasma and whole blood and the patient expired on the fortieth postoperative day. Postmortem examination was refused.

Ruptured primary jejunal ulcer has been reported but there were none in the present series.<sup>68</sup>

Complications most frequently encountered involved the operative incision (wound infection, dehiscence and evisceration) and

the respiratory tract (upper respiratory infection, pneumonia, empyema, and atelectasis).

During the past two years plasma protein levels were closely studied in an effort to evaluate the level associated with gastroduodenal perforation and to avoid hypoproteinemia. The average level recorded was 6.42 mg., the highest 9.27 and the lowest 4.43. The average level is definitely at the lower limit of normal and more than 50 per cent of the patients exhibited definite hypoproteinemia. However, only one patient developed clinical evidence of hypoproteinemia. The problem of hypoproteinemia in the surgical patient has been frequently stressed.<sup>69,70,71</sup>

Reference has been made to the association of a lowered ascorbic acid blood level with peptic ulcer,<sup>72,73</sup> and to poor wound healing.<sup>74,75</sup> Estimations were conducted in eighteen patients. The average level was 0.64 mg., the highest 0.82, and the lowest 0.38 mg. These patients exhibit low ascorbic acid blood levels but none reached a scurvy level.

#### COMMENT

The diagnosis of ruptured gastroduodenal ulcer should be made without great difficulty in nearly every case. Close questioning of the patient will elicit a history suggestive of or definite of ulcer in 75 per cent of the cases. The sudden onset of the present illness and the severity of the pain with rapid spread throughout the abdomen and perhaps to one or both shoulders will frequently lead one to suspect the diagnosis. The physical signs that are outstanding are the board-like rigidity of the abdomen and "silent" abdomen to auscultation. Diminution of liver dullness and roentgenographic evidence of pneumoperitoneum are pathognomonic for a ruptured viscus. Ingestion of a dye solution by mouth and recovery by peritoneal aspiration is pathognomonic of ruptured gastrointestinal tract. When a diagnosis of perforated viscus cannot be confirmed by the pathognomonic features mentioned deter-

mination of the serum amylase should be made to exclude the possibility of acute pancreatitis. When laparotomy is decided upon the patient should be given intravenous fluids preoperatively, if necessary, to combat shock or dehydration. Morphine should be freely employed. An empty stomach should be insured by preoperative gastric extraction by nasogastric tube and Wangensteen suction which should be continued through the operation and post-operative phase. Spinal anesthesia facilitates the operation. A small high incision should be employed and simple plication reinforced with omentum should be the only procedure in the majority of cases. If the patient is an exceptionally good operative risk, if the perforation has been present less than six hours, if the degree of peritonitis is not advanced, and the operator has considerable experience at gastric resection, primary subtotal gastric resection should be considered. When the perforation has been present more than six hours, the intraperitoneal application of sulfonamides is mandatory. Extreme care must be used in carefully closing the incision. Retention sutures should be employed and steel alloy sutures can be used advantageously. Postoperative care should emphasize avoiding gastric dilatation by continuous gastric suction, prevention of anoxia by routine administration of oxygen preferably by masks during the critical postoperative period, intelligent administration of fluids; whole blood, plasma or glucose and saline; early recognition and treatment of hypoproteinemia and vitamin deficiencies.

#### SUMMARY AND CONCLUSION

The subject of perforated peptic ulcers has been reviewed, as well as the etiological factors involved, the symptoms and diagnosis, and operative procedures. The series at the Metropolitan Hospital from 1930 to 1941 inclusive may best be summarized by the accompanying table. A series of eighty-nine consecutive and unselected cases are presented. Eighty-seven of these patients

ACUTE PERFORATION OF GASTRODUODENAL ULCER 1930-1941	
Total hospital admissions.....	132,000
Perforated peptic ulcers.....	89
Incidence.....	0.0006
Operated by surgical service.....	87
Diagnosed at postmortem.....	2
Age	
Average.....	45.1 years
Youngest (one eleven months of age since present series).....	21.0 years
Oldest.....	77.0 years
Sex and Race	
White male.....	82
White female.....	1
Colored male.....	2
Colored female.....	2
History	
Definite previous ulcer history.....	34
History suggestive of ulcer.....	29
Present illness only.....	24
Physical	
Diminished liver dullness of cases examined.....	50%
Roentgenographic evidence of pneumo- peritoneum of cases examined.....	50%
Shock.....	10%
Hemorrhage.....	15%
Number of hours perforation occurred prior to admission.....	8.48 hr.
Ten patients perforated while on wards receiving treat- ment for ulcer	
Number of hours perforation occurred prior to operation.....	11.09 hr.
Correct preoperative diagnosis.....	89.7%
Missed diagnosis.....	10.3%
Appendicitis.....	8 cases
Intestinal obstruction.....	1 case
Site of Perforation	
Anterior gastric.....	9
Posterior gastric.....	1
Anterior prepyloric.....	40
Posterior prepyloric.....	2
Pyloric.....	10
Anterior duodenal.....	22
Posterior duodenal.....	3
Procedure	
1. Simple plication with or without omentum.....	48
and jejunostomy.....	1
Deaths.....	11
Mortality.....	22.4%
2. Same (1) plus drainage and jejunostomy.....	21
Deaths.....	7
Mortality.....	31.8%
3. Excision and plication.....	2
Deaths.....	0
Mortality.....	0%
4. Same (3) and drainage.....	1
Deaths.....	0
Mortality.....	0%
5. Simple plication and appendectomy. and appendicoecostomy.....	3
Deaths.....	2
Mortality.....	50%

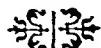
6. Simple plication, appendectomy, and drainage.....	1
Deaths.....	0
Mortality.....	0%
7. Simple plication and gastroenteros- tomy.....	3
and jejunostomy.....	1
Deaths.....	0
Mortality.....	0%
8. Simple plication, appendectomy, gas- troenterostomy and drainage.....	1
Deaths.....	1
Mortality.....	100%
9. Catheter through perforation, flush abdomen with saline and drain- age.....	1
Deaths.....	1
Mortality.....	100%
Gross Mortality is 25.2%	
Anesthesia	
Nitrous oxide, ether and oxygen.....	29
Cyclopropane and oxygen.....	41
Spinal.....	13
Novocaine block.....	2
Not specified.....	2
Length of operation	
Average.....	53.02 min.
Shortest.....	18.00 "
Longest.....	170.00 "
Bacteria cultured from peritoneum	
Staphylococcus	
Streptococcus	
Bacillus coli	
Pneumococcus	
Complications	
Wound infections.....	27
Dehiscence and evisceration.....	10
Hernia.....	3
Paralytic ileus.....	1
Peritonitis.....	8
Subphrenic abscess.....	2
Duodenal fistula.....	2
Pyloric stenosis.....	1
Pneumonia.....	14
Empyema.....	2
Atelectasis.....	6
Upper respiratory infection.....	2
Tonsillitis.....	1
Abscess of arm.....	2
Abscess of leg.....	2
Parotitis.....	1
Cardiac failure.....	4
Shock.....	9
Hypoproteinemia.....	1
Alkalosis.....	1
Delirium tremens.....	2
Plasma proteins	
Average.....	6.42
Highest.....	9.27 (15)
Lowest.....	4.43
Ascorbic Acid	
Average.....	0.64
Highest.....	0.82 (18)
Lowest.....	0.38
Number of hospital days	
Average.....	28.14
Shortest.....	12
Longest.....	93

were on the surgical service and operation performed in each case. Postoperative care is stressed and emphasis placed on the possibility of accompanying hypoproteinemia and vitamin deficiency.

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# PERFORATING WOUNDS OF THE INTESTINE

## SATISFACTORY METHOD OF TREATMENT FOR WOUNDS MORE THAN TWENTY-FOUR HOURS OLD

THOMAS B. NOBLE, JR., M.D.

Visiting Surgeon, Methodist, St. Vincent's and Hamilton County Hospitals

INDIANAPOLIS, INDIANA

THE last war taught us some rather definite lessons regarding the relation between the element of time and the surgery of perforating wounds of the intestine. Conclusions made then were statistical in nature. It was the commonest observation and experience that surgery was attended with favorable results if done within the first twelve hours after injury; and that results were increasingly bad after this time. After a lapse of twenty-four hours between injury and treatment, about 90 per cent died, whether operated or not.

In 1917-1918 the writer performed many and witnessed more autopsies while attached to 64 C.C.S., B.E.F., and B.G.H. 12, on cases of all kinds of military wounds fatal in outcome. Those succumbing to perforating abdominal wounds, both operated and not operated, routinely subjected to autopsy, confirmed the time table basis of treatment and gave the pathologic changes back of this at the same time. Memory keeps the findings of those days clear. In them, peritonitis had been found well established at the end of twenty-four hours or at the time of surgical intervention. Chemical, infectious, and traumatic types of peritonitis were recognized. In operated cases coming to autopsy the sutured perforations were usually found ununited and reopened. Exudation and fluid accumulation were universally noted, whether drains had been used or not. We were confused in thinking and judged that the peritoneal cavity could not be drained adequately by any means; not interpreting the multiple abscesses as evidence of multiple localizations, rather than as fail-

ure of drains to perform properly. We always noted at autopsy a marked distension of the small bowel with kinking, angulation, fixation, gangrene, mesenteric thrombosis, which became the recognized complex picture of the fatal case of gunshot wound of the abdomen for whom too many hours had passed before satisfactory surgical treatment could be reached.

Since those days and from the basis of this earlier experience, the writer has undertaken constant research aimed at the reformation of our accurate knowledge of the sequences of peritonitis that have been allowed to develop for more than twenty-four hours. He has turned this into a method of therapy for these cases that has proved to be a logical and active plan of treatment based on the facts of pathology as we know them; and has thereby allowed the surgeon using this understanding and this method to be in command of his results. These hopeless cases, faced with a 90 per cent fatality in 1917-1918, may now stand that percentage chance of recovery, recovery without later morbidity, from the same types of injury and the same delay in coming to adequate surgery.

In civilian life we do not see gunshot wounds of the abdomen commonly. There are many other conditions, however, that are analogous in almost all respects. The common denominator, the sequences of peritonitis, make all these cases subject to the method of management to be shown. We have met some gunshot wounds of the abdomen, stab wounds, football injuries, auto accidents, nonclassified trauma, ruptured appendices, ruptured ovarian cysts,

endometriosis, infected, ruptured uteri, puerperal sepsis; pneumococcic peritonitis, intussusception, foreign bodies, ruptured diverticuli and ulcers, ruptured gallbladders, and a host of other conditions which require like treatment because of the underlying common denominator—the sequences of peritonitis. With such a complex set of conditions setting up all sorts of peritonitis in all degrees of extension and going on for more than twenty-four hours into wide dissemination, we have found that our most serious problems are not those subsequent to gunshot wounds but those following the rupture of the appendix which lies over the midline after drastic catharsis. This follows properly, we believe, because this type of appendicitis shows an early increase of intra-abdominal fluid, virulent organisms are present early for widespread dissemination throughout this fluid, and the peritoneum has had no preparation for infection. With the case of gunshot wound and perforation of the intestine, chemical insult precedes bacterial development through the action of the juices of the small bowel, so that localization is under way before infection germinates. Our statistics of cases of all causes treated late, that is more than twenty-four hours after perforation of the bowel or the development of infectious peritonitis from some other source, are better than 90 per cent recovery. The illustrations used here are all from cases of bowel perforation or rupture, some having gone for as long as a week before treatment; all recovered completely.

The military field of surgery is of great importance again. Even though civilian life may see more peritonitis, it is highly important that the soldier suffering a perforating gunshot wound of the abdomen and lying in some no-man's land for more than twenty-four hours has access to an improved therapy which offers recovery without sequelae and later threat from obstruction, in other words, a complete recovery fitting him for a life of active duty rather than the invalidism formerly

seen from adhesions in the case of one who managed to survive.

Returning to the picture of the conditions seen at autopsy of the fatal wounds of the abdomen during 1917-1918, it is well to analyze the causes of failure of surgery from our present knowledge and experience. As we have now learned the sequences of peritonitis there is early violent reaction attended with swelling and exudation of serum, fibrin and pus. Quick walling off is seen. Very rapid disappearance of general peritoneal inflammation is the rule, as multiple localized abscesses are formed. At these areas multiple intestinal obstructions are formed, several being met at the site of a single localization. In the region of a perforation early walling off permits the development of fistula and prevents the scattering of infection.

All fatal gunshot wounds of the first World War were considered to be composite pictures. The minor damage from searing of the peritoneum by passage of a bullet was followed invariably by adhesions during repair effort. In any proper method of treatment this simple degree of damage had to be considered in order to prevent unwanted adhesions affecting the outcome unfavorably.

Areas of perforation, closed carefully some days previously, had opened. This was due apparently to exudation and swelling causing nonunion, as well as nearby distal obstructions causing distention of the bowel at the region of suture. The kind of suture or manner of suture had no part in the bad result we concluded.

Fluid accumulation was marked, and it was our opinion that this was partly due to peritonitis and largely due to distention from obstructions. Death seemed to be due to the toxicity of multiple obstructions, or gangrene of gut and mesentery at points of abscess localization and obstruction. Starvation and septicemia were judged as terminal symptoms of the above states.

Of most surprising note was the fact that almost all of the intestinal and parietal

peritoneum had recovered from the infectious and chemical inflammation, even though the progress of the patient had

as culture media and vehicle for spread of infection; we must relieve all partial and complete obstructions already existing at

FIG. 1.



FIG. 2.



FIG. 3.



FIG. 4.

been continuously downward to fatality without any clinical sign of such recovery. Only at areas of localization and abscess causing obstruction was peritoneal damage or loss noted. The price of recovery from peritonitis then might be said to be the loss of life through the obstructions produced by the mechanism of recovery.

Some problems present themselves if the above mentioned sequelae are to be prevented. If these cases of late gunshot wounds with perforation and peritonitis are to recover, we must evidently accomplish the following: We must prevent obstruction forming from areas of minor trauma such as seen; we must prevent obstruction forming where sutured areas naturally adhere to adjacent structures; we must prevent obstructions so that fluid accumulation will not occur to act

areas of localization, and prevent any degree of return, ever; we may disregard the infectiousness of the pus of the existing abscesses and fluid accumulated; and lastly, we must consider a damaged omentum as a threat and repair or remove that part where there may be damaged peritoneum.

A series of photographs, taken from several different cases is used to picture the actual conditions and the problems to be met. Black and white photography does not reproduce satisfactorily the accumulation of pus and fluid, the butter-like plastic exudates, the loss of peritoneal surface through granulomatous change, and other facts of the true picture nearly so well as color slides.

Figure 1 was made upon opening the abdomen about a week after perforation.

The first loop of partially obstructed bowel was well adhered low in the pelvis: Note here the absence of general peritoneal

Figure 5 shows another type of abscess. All kinds of lesions may be found in any one case; each lesion is often found sepa-

FIG. 5.



FIG. 6.



FIG. 7.



FIG. 8.

damage. After dissection from its point of attachment, Figure 2 shows the area of peritoneal damage, local, due to adhesion at an abscess site. Note the distention due to obstruction and the mesenteric lymph adenitis.

In Figure 3, as dissection of attached bowel is carried on, considerable peritoneal damage is evident. Though once freed, so much damage exists that obstructing adhesions will form if this intestine is merely returned to the abdomen. Boys<sup>1</sup> has admirably reviewed and summarized methods used to prevent adhesions forming from such areas of damaged bowel.

Figure 4 shows the aspiration of a large collection of pus from an abscess at the root of the mesentery. Note the clean peritoneum of the loop of intestine supplied by the mesentery involved.

rated from another by a length of bowel whose peritoneum is undamaged, as shown here. The individual photographed here was operated upon June, 1942, and is now in the parachute troops; plications are still intact. He appears again in Figure 12, showing some of the final stages of his surgery.

Figure 6 is a smaller unseparated abscess lying between two remote areas of small bowel. This is unusual, as most abscesses are formed between a loop of intestine and the mesentery of a nearby loop. Volvuli, fixation with strangulation, may result from this sort of condition.

Figure 7 portrays the result of as careful a dissection as can be done in the separating of loops adhered about abscess areas. Two parts of intestine are seen denuded of peritoneum and left raw and oozing. Un-

fortunately, it has not been found possible to photograph undisturbed states. Dissection must be completed and the damaged

small bowel plication is done in single wing as diagrammed and described elsewhere.<sup>2,3</sup> To repeat, a running suture of any mate-

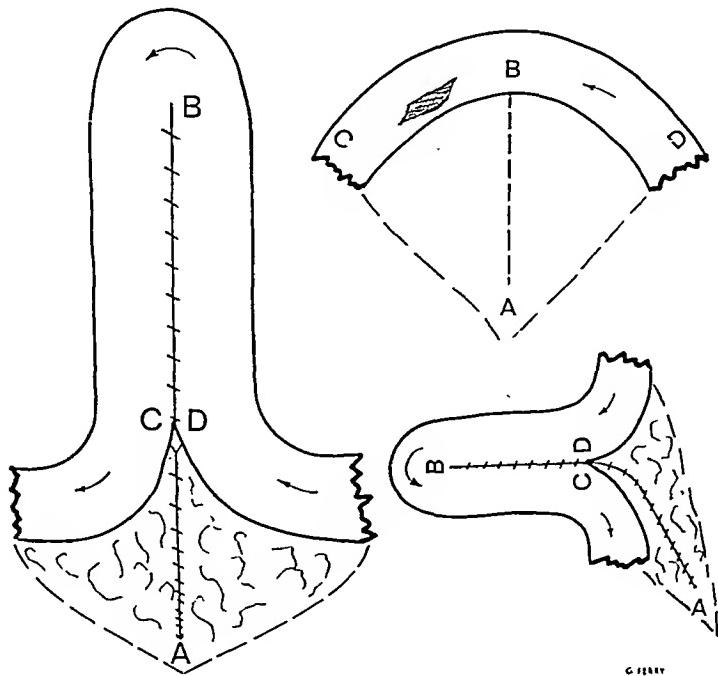


FIG. 9.

or involved loops brought to the surface for adequate lighting and separation of planes. Yet it is possible to reconstruct the condition meeting the fingers during that dissection, through the mind's eye playing on surgical experience.

Figure 8 shows how it may be necessary to deliver much of the bowel in order to uncover a loop adherent deep at the root of the mesentery. Inflammation here had destroyed most of the peritoneum of a considerable portion of gut, and some danger is present in the separation of adherent surfaces. Yet this must be done completely in order to untangle all degrees of obstruction obviously present in all these photographs.

These few illustrations serve to exemplify the pathologic sequences of peritonitis which produce the problems to be solved by surgery.

In Figure 9 the simplest unit of plication is shown. To cover a damaged mesenteric or intestinal peritoneum of the

rial, begun at point, A, is continued on, bringing lines, AC and AD, together to form line, A\*CD, then continued as desired to cover the area to point, B, at the wing apex.

Figure 10 shows a three-wing plication which will cover raw areas on four surfaces of mesentery and intestine. The lettering is arranged to show juxtaposition of single units of plication.

Figure 11 demonstrates the application of single units varying in size as desired and placed adjacent to each other so that the effect is a continuous plication. In each unit the suture is always started at the root of the mesenteric fold, closing it tightly. The entire small bowel may be plicated, and it is safer to plicate completely than to miss covering one raw area.

Figure 12 portrays the suture CD\*B as in Figure 9. Just to the right of the suture is a badly damaged zone of intestinal peritoneum which will be covered by another wing such as in Figure 10. Obstruc-

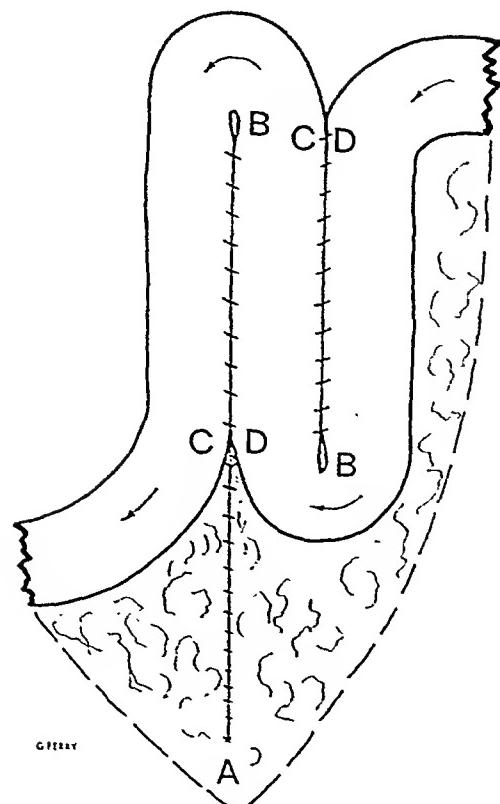


FIG. 10.

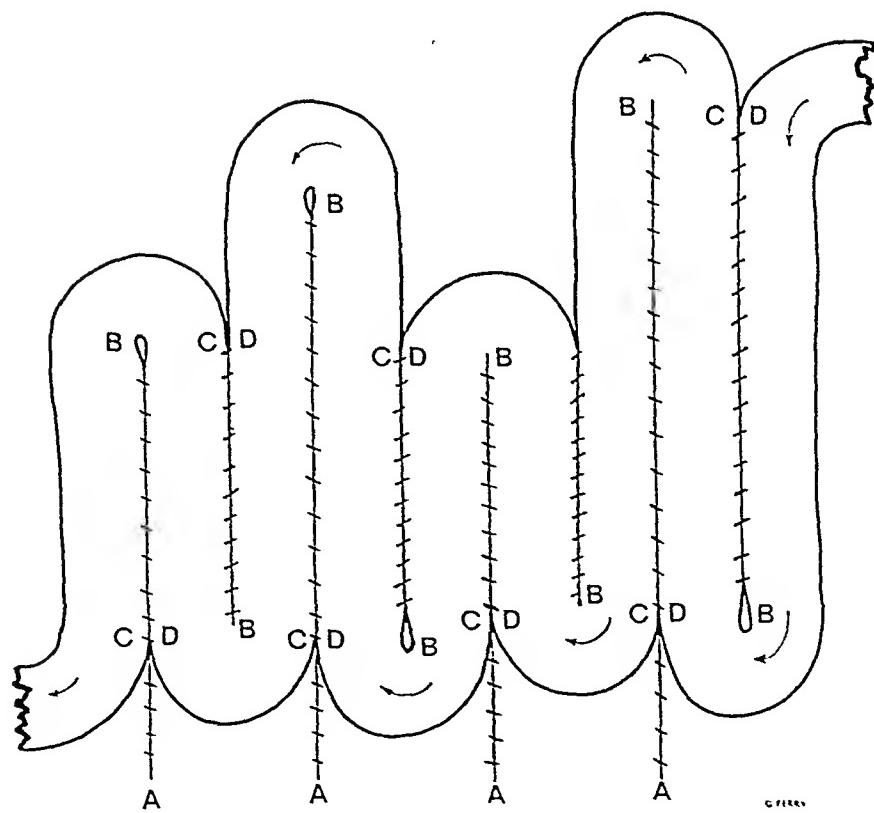


FIG. 11.

tion, local damage, general peritoneal recovery are all shown here as well.

Figure 13 shows a completed single wing

anatomy, and so does not enter into the province of the material of this paper.

Figure 16 shows four completed plica-

FIG. 12.



FIG. 13.



FIG. 14.



FIG. 15.

in another case, suspended by the uncut suture. It is obvious here that the suture line is well hidden by the shape of the gut in plication, so that unwanted adhesions to it are avoided.

Figure 14 is a completed wing of plication over an abscess area involving mesentery and gut. Obstruction is evident as is the need for more plications.

Figure 15 shows four adjacent or continuous wings of plication completed. Other wings may have been completed and replaced, and more may follow, but this is as much as is usually allowed outside the abdomen at any one time. Incisions are rarely extended above the umbilicus unless colonic damage requires this. Colonic repair is simple since it cannot become involved in obstruction because of its

tions again continuous. Since the damaged peritoneum of mesentery and bowel adhere very quickly we use plain No. 00, but anything may be used.<sup>4</sup>

Figure 17 demonstrates a mildly damaged intestinal peritoneum plicated to cover damage to mesenteric peritoneum from a large abscess following trauma and perforation of the ileum existing for one week before surgery. This part of the gut is well away from the zone of localization, but mesenteric damage makes plication necessary. After dissection, distention tends to disappear rapidly, being more generally distributed, yet is evident here.

Figure 18 shows a collapsed bowel, nearly normal in appearance, plicated in at least four continuous wings. This is included as evidence in routine plication past the zone of most severe damage. The zone

of plication or the active steps taken to prevent unwanted adhesions and obstruction, the natural sequences of peritonitis or

form of angulation for one already present due to inflammation. The difference in effects between the uncontrolled, abnormal

FIG. 16.



FIG. 17.



FIG. 18.



FIG. 19.

peritoneal damage, must extend well beyond all regions of evident involvement. It does no harm to plicate the normal bowel. Failure attends incomplete plication, as it attends all incomplete therapy.

Figure 19 illustrates the end result after multiple plications for disseminated peritonitis with established multiple abscesses and complete obstructions with marked distention. This picture secured some fourteen months after operation is significant. The clinical behavior has been uneventful in all respects since the recovery more than a year ago. Note here the complete absence of any evidence of obstruction, slowed intestinal current, or other interference with normal function of any part of the bowel concerned. Some have expressed the notion that permanent fixation in plication is merely substituting a

angulations of inflammation and the controlled plications of the surgeon is seen in this photograph. The actual appearance of the bowel after plication and recovery has been difficult to record on film, since no patient has had to be re-operated upon for an effect resulting from plication. This photograph, secured because of unrelated pathological disorders, has provided visual evidence correlating the clinical behavior of cases with anatomic and physiologic results of the treatment method. No deviation from the normal condition has been produced.

Much of the work mentioned antedated the advent of the sulfa drugs.<sup>5</sup> Their place is well known and applied today. Some of our patients have been operated upon in the home without the benefit of plasma, blood transfusion or even glucose. The

method of treatment has stood up under these handicaps, and so is judged to be applicable to conditions seemingly more primitive, such as present battlefield conditions; yet the equipment of modern medical units with plasma, sulfa drugs, and spinal anesthesia is certainly less primitive than some kitchen surgeries we have used.

#### CONCLUSIONS

It is seen that there are reasons why failure attends any method of handling perforating gunshot wounds of the intestine unless certain pathologic sequences are understood. Peritonitis is not often or usually to be feared because of its infectious toxicity; it is the obstructive element always produced by the early, rapid, processes of localization or repair ability that kills. Surgery, therefore, must control all tendency toward obstruction resulting from injury or inflammation. The method of plicating the gut as illustrated has proved to be adequate as desired in some hundreds of cases of all degrees.

Additional supportive measures after surgery, such as blood transfusion, plasma infusion, are as much a part of the care of the case of advanced peritonitis treated as are food, drink and rest to our normal life. We prevent shock during and after surgery by such methods at hand today.

We prefer spinal anesthesia as we want active peristalsis as soon as possible to follow our surgical efforts. Immediately after surgery we begin pituitrin (no other

substitute is as free of disadvantage) hourly until the abdomen is empty and fluid stools are had with each injection. Then we begin feeding along the same lines followed in clean surgery. After complete plication obstructive signs cease and convalescence is very rapid, even though a hard rubber drain into the bottom of the pelvis shows much colon-type pus to be forming over a period of time postoperatively. Since abscesses are multiple in number, type, and size in any case, a drain is always left down to the bottom of the pelvis and brought out through a stab wound so that there will be no fluid accumulation about the pelvic colon.

Using our present rather definite and accurate knowledge of the pathological sequences of peritonitis and their effects, a method of therapy has been applied to them which has prevented the unhappy outcome known surely to follow the existence of intestinal perforations for more than twenty-four hours. This method has given better than 90 per cent recovery in place of the former 90 per cent fatality.

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# DIAGNOSIS AND TREATMENT OF OBSTRUCTION OF THE SMALL INTESTINE\*

MAJOR LOUIS C. BENNETT, M.C.

Army of the United States

MATHER FIELD, CALIFORNIA

SINCE early in the twentieth century when intestinal obstruction was first accepted as a surgical rather than a medical problem, the mortality rate has been reduced from approximately 70 per cent to below 20 per cent, and in carefully selected series to well below 10 per cent. In reviewing the literature for this entire period one is impressed with the vast amount of work and study, some of which has been fruitful only in a negative way; but in general the trend has been toward an understanding of the mechanical and chemical derangements that ensue when the continuity of the intestinal tract is interrupted either on an organic or physiologic basis. The notable reduction in mortality rate has been accomplished by the clinical application of the factual contributions which have resulted from the extensive experimental work, the literature of which is too voluminous to cite, and from the analysis by close observers who have conscientiously recorded the merits of the clinical procedures which have been introduced from time to time in the treatment of various types of intestinal obstruction. Thus, the aggregate information available to the surgeon of today is the result of approximately half a century of experimental and clinical work and should be reflected in a lowered mortality rate. This will be, however, only if the surgeon adheres to the basic principles of early diagnosis, early surgical management and the maintenance of fluid and chemical balance.

The diagnosis can be made no earlier than the physician is privileged to see the patient, but too frequently the early mani-

festations of obstruction are not properly evaluated by the physician, and an adequate program of management is not instituted. A carefully taken history with particular attention to previous operations, repeated similar attacks, the patient's observation of distention and borborygmus during attacks and the type, severity, character and location of the pain should make the physician obstruction minded. The physical examination should be thorough and should include careful inspection of the abdomen for evidence of external hernias and surgical scars, and gentle superficial palpation for tenderness. Any tenderness elicited should be carefully noted and localized as accurately as possible, because upon this may depend the final diagnosis. Rushes of peristalsis may be palpated, but with the exception of gastric peristalsis which results from obstruction at the pylorus, I have not been able to visualize peristaltic rushes with dependable accuracy. Deep palpation for masses must be carried out with the greatest of care, especially in the presence of any degree of tenderness. Of the greatest value, and too frequently overlooked, is the use of the stethoscope as an aid in the diagnosis of intestinal obstruction. Prolonged auscultation of the abdomen may reveal increased peristalsis with high pitched sounds, true metallic tinkles or rushes of fluid and gas not heard in the normal abdomen; or in a patient suspected of having paralytic ileus the complete absence of normal intestinal sounds may be the confirming factor. Too much time cannot be spent upon these relatively simple procedures, because in some cases

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these plus the scout roentgenograms of the abdomen may constitute the entire investigative program which one is entitled to carry out, and from the information obtained the diagnosis must be made and the plan of treatment decided upon. Especially since the introduction of the Miller-Abbott tube method of dealing with certain types of obstruction, the diagnosis of intestinal obstruction in the broad term is not sufficient if one is to select intelligently the type of management best suited to the individual case. Therefore, the completed diagnosis should be not only of the level of the intestinal tract involved, but the type, the cause if possible, the duration, and the complications which may have occurred. These differentiations may be obvious after a detailed and carefully interpreted record, but it is in the obscure case that the minute detail may be the deciding factor. Wangenstein<sup>1</sup> has pointed out that the interpretation is perhaps of more importance than the clinical observation in that when an error is made it is more apt to be one of interpretation than one of observation. Particularly is this true in differentiating the typical rhythmic colicky pain of simple organic obstruction from the steady, severe, localized pain which is characteristic of strangulation obstruction, and this differentiation is all important from the standpoint of management.

The x-ray, if judiciously used, is a valuable accessory aid to the diagnosis of acute intestinal obstruction, but in the hands of the overzealous it is prone to further the complications. As previously stated, the scout roentgenograms may be the only films which one is entitled to make, and a meticulous analysis of such films frequently provides valuable information. It has been demonstrated experimentally that distention of the small intestine becomes obvious in the scout film as early as four hours after complete obstruction. The localized loop of gas-filled small intestine in a patient suspected of having a strangulation type of obstruc-

tion may be confirmatory, or the presence of distended loops of small intestine separated by free fluid with generally hazy soft tissue outline may be the picture of obstruction complicated by peritonitis, or vice versa. It has been demonstrated elsewhere<sup>2</sup> that distention of the small intestine existed in 81.8 per cent of a group of cases of obstruction of the colon from various causes. Therefore, even extensive distention of the small intestine does not eliminate the colon as the possible level of the obstruction. It has also been my experience many times to observe distention of the small intestine with considerable gas in the colon on the films of patients with advanced paralytic ileus necessitating Miller-Abbott intubation decompression. However, the hasty administration of the barium meal for routine gastrointestinal x-ray examination as a diagnostic aid in known or suspected cases of intestinal obstruction is a hazardous procedure. Rankin and Graham<sup>3</sup> have described the oral meal as a positive menace in the presence of an obstructing lesion of the colon, and in the presence of obstruction of the small intestine the menace is even greater. This is generally agreed upon by the roentgenologist and the surgeon, but the frequency with which patients with some degree of obstruction receive barium by mouth makes it worthy of mention. A small amount of a thin mixture of barium in water given cautiously may provide some valuable information; but if there is a question of developing acute obstruction, time and subsequent scout roentgenograms will confirm the diagnosis as accurately and with less risk of additional complications.

The practice of instituting Levin tube suction, pending the diagnosis, during the study or observation period of a patient suspected of having any type of organic obstruction is as undesirable as prolonged observation for acute appendicitis. In simple organic and physiologic obstruction, the diagnosis is made chiefly upon the factor of distention and the resultant local

and generalized effects. Wangensteen<sup>4</sup> has proved experimentally and it has been pointed out elsewhere<sup>5</sup> that exclusion (or recovery) of swallowed air and liquids will halt or retard the progress of distention above an obstruction; but that if an obstruction exists, Levin tube suction is not adequate management. Therefore, the Levin suction not only does not aid in the diagnosis, but its use may further complicate the picture and valuable time will be lost. Intubation with the Miller-Abbott tube is a valuable adjunct to the treatment of acute intestinal obstruction, but it should be used only after every effort has been made to arrive at a satisfactory differential diagnosis as to the type of the obstruction. Intubation offers no safe aid in the differential diagnosis, and its use combined with wishful thinking may be responsible for some temporary false improvement but a fatal outcome should the obstruction be of the strangulation type. I have had the experience of instituting intubation management for obstruction in a patient upon whom I had made the diagnosis of simple adhesive obstruction, of deciding too late that there was interference with the blood supply to the bowel, and of seeing my mistake at autopsy. This emphasizes the fact that should the question of vascular integrity exist, or should it arise after intubation therapy has been instituted, the process of intubation should be abandoned and the patient should be operated upon immediately.

The diagnosis of acute intestinal obstruction then depends largely upon a critical interpretation of the clinical history and findings and the additional help which one can obtain from such x-ray work as can be done without sacrificing the safety of the patient for detail of diagnosis. As far as I know, there are no short-cut methods which will either assure one of the diagnosis, or of the most favorable method of management of obstruction.

The management of the obstruction *per se* differs with the type, and within the same type, with the duration and with

the complications which have developed. As with acute appendicitis, the mortality rate usually results from the complications and not from the uncomplicated, early adequately treated obstruction regardless of the type.

Without going into the details of the various strangulation obstructions, strangulated hernia, intussusception, volvulus, or internal hernia or strangulation, such a diagnosis, known or suspected, is an indication for immediate laparotomy and a direct surgical attack upon the cause of the obstruction. Gastric lavage with a large tube followed by a Levin tube No. 18 passed through the naris and left in throughout the operation will recover the intestinal content which is regurgitated into the stomach and will insure against aspiration. Correction of fluid and chemical imbalance can be started probably best by giving blood plasma generously and the correction can be continued on the operating table. What must be done surgically depends upon the amount of damage to the bowel as the result of circulatory embarrassment. When the bowel wall is cyanotic, edematous and discolored but not definitely devitalized, warm saline packs applied to the bowel after the strangulation is released while pure oxygen is administered to the patient will aid in determining if the damage is beyond repair. If resection is necessary, an end-to-end anastomosis well away from the damaged area without an enterostomy is preferable. Although enterostomy was formerly thought to be necessary to relieve the distention of the bowel, this factor is far better controlled by the Miller-Abbott tube. In most instances the postoperative distention is a manifestation of the ileus which results from the insult to the bowel and it has been demonstrated repeatedly that intubation decompression is the management of ileus. The distention is adequately relieved, thereby relieving the tension against the suture lines and hastening the return to normal function of the bowel. The possible complication of peri-

tonitis as the result of prolonged untreated strangulation obstruction of the small intestine does not contraindicate surgery although the risk of surgery is greatly increased. However, there is no other type of treatment which offers any more expectant outcome. In such a situation the postoperative use of the Miller-Abbott tube is urgent.

Since the advent of the Miller-Abbott tube, considerable controversy has arisen as to the management of organic obstruction of the small intestine where it can be determined with dependable certainty that the blood supply to the bowel is not embarrassed. This group, in the absence of peritonitis, lends itself to the greatest variation of methods of management, and as long as strict surgical principles are followed sufficiently early, the outcome will be uniformly good. For clarification as to methods of management, the post-operative adhesion obstructions may be divided into those which occur within the immediate postoperative period, and those which occur months or years following abdominal surgery. The former, occurring frequently following operations for intra-abdominal inflammatory conditions, acute gangrenous or perforated appendicitis, pelvic inflammatory disease, or following operations which predispose to local or general peritonitis, are usually associated with some degree of peritonitis, and prior to the use of the sulfonamide drugs, any further surgical procedure carried a very high mortality rate. It is in this subgroup that intubation decompression is probably of the greatest value as an adjunct to the surgical management of acute intestinal obstruction. Many surgeons have had the gratification of seeing such patients not only improve rapidly following adequate intubation, but of seeing the obstruction release without further intervention. Three such patients upon whom I performed intubation decompression in 1939 have been perfectly well with no symptoms of recurrent obstruction since. It must be remembered, however, that these are

serious complications and that they merit serious consideration. The results of intubation therapy will be gratifying only in proportion to the amount of skill and time given to the procedure. It is not the purpose here to discuss the technic of intubation, but there are few procedures in medicine which may require more time, patience, and perseverance. Many surgeons, who are familiar with the principles but not the practice of intubation, have disregard for it because, in their experience, the procedure has been relegated to inexperienced members of the house staff. In these serious complications only a surgeon who is familiar with all phases of intestinal obstruction and with the various technics of intubation as well as the alternatives when intubation is unsuccessful, should assume the responsibility.

The simple organic obstructions of the small intestine which occur months or years after abdominal surgery, or which occur on other bases in the absence of intraperitoneal inflammatory process, allow for the greatest variations in therapy. From the standpoint of management these cases may be divided into (1) those seen early, and (2) those seen late in the process of developing distention. Many of these patients give a history of repeated attacks suggestive of temporary or partial obstruction and they are definitely surgical problems. The duration of the present attack is important. If the attack has not progressed as far as to have approached the dangerous stage of pending peritonitis manifested by pronounced distention, decreased peristalsis, dehydration, fever and leukocytosis, the patient may be operated upon at once with the intent of freeing up the obstruction. In many instances a simple operation performed early will effect an immediate cure although no assurance can be given against recurrence of obstruction on the basis of reformed adhesions. There is, of course, the rare patient who has had multiple operations for recurrent obstruction of the small intestine, who gives a history of repeated

attacks of abdominal colics since the last operation, and who sooner or later develops all the symptoms and signs of acute obstruction. Rarely is such a patient benefited permanently by surgical release of the obstruction during the acute attack. It would seem preferable to perform intubation decompression for relief of the distention in the hope that subsequent to decompression the obstruction may release. If the obstruction persists the patient may be operated upon at the most optimal time without the disadvantage of distention of the intestine.

The patients with acute simple organic obstruction seen late in the process of developing distention present a much more delicate problem from the standpoint of management. Unfortunately, in the sequence of events which follow complete obstruction of the small intestine, there is no definite index as to when a patient enters the dangerous stage of obstruction, but the duration, the fading out of rhythmic hyperperistalsis, the presence of generalized abdominal tenderness, and the degree of dehydration, fever and leukocytosis are observations which must be given serious consideration. It must be remembered that prolonged and progressive untreated distention is the factor responsible for the complications and fatalities which occur from simple organic obstruction, that peritonitis can occur without frank gangrene of the bowel wall, and that the later in the process surgery is performed the greater are the hazards. Adequate intubation decompression at this dangerous stage relieves the distention by evacuating the gas and liquid content of the bowel above the point of obstruction and prevents the recurrence of distention as long as the tube and suction continue to function. Under such management a patient who has approached the complication stage of acute obstruction of the small intestine will show marked improvement as soon as the decompression becomes effective, and although the obstruction may remain complete, surgery may profit-

ably be deferred until the restoration has become complete in all phases. Dehydration and chloride deficiency can be corrected in part, and the morale of the patient can be greatly improved by allowing fluids and salt as soon as the patient will tolerate them. Several days should be allowed for subsidence of the edema of the bowel wall before surgery is performed. It has been our practice to leave the tube in at the time of surgery and to continue suction for a variable period after surgery, depending upon the magnitude of the operation. If starvation diet and intubation suction are continued for a long time, vitamin K should be given to avert prothrombin deficiency. Our method of determining return of bowel function is simply to discontinue suction and to leave the tube in until bowel function has been demonstrated or distention has developed. In the presence of severe postoperative ileus, it is frequently necessary to reestablish suction and test the function at a later date.

The condition recognized as adynamic ileus now presents no problem as to the choice of management, but often the problem is "when to intubate." Too frequently temporizing methods are employed: hot or cold stupes, various drugs including laxatives, enemas, colon tubes, and Levin tube suction. Although paralytic ileus may be present in some degree and subside with the use of these remedies, it is impossible to determine when the physiologic obstruction is going to persist and become a major problem. From the frequent observation of gas in the colon demonstrated by scout roentgenograms of the abdomen of patients with extensive adynamic ileus, it is probable that the entire intestinal tract is affected. Therefore, it is not logical to expect treatment limited to either end of the intestinal tract to empty the entire bowel with any degree of efficiency. It has been demonstrated that Miller-Abbott tube decompression will progressively empty the flaccid small intestine and that normal intestinal activi-

ity will resume when the decompression is complete. The progress of the tube is slower and the entire process requires more time than intubation in the presence of the hyperperistalsis of organic obstruction. In several instances it has been necessary partially to withdraw the tube in order to evacuate gas and fluid which have accumulated in the bowel above the tip of the tube. It has also been necessary to pass a Levin tube into the stomach through the opposite naris and maintain suction to the stomach while progressive decompression of the small intestine was accomplished by intubation with the Miller-Abbot tube. Levin tube suction, however, cannot be considered adequate management of the distention of adynamic ileus. In persistent adynamic ileus intubation decompression and the maintenance of fluid and chemical balance fulfil the requirements of adequate surgical management.

#### SUMMARY

The diagnosis of obstruction of the small intestine depends largely upon an exacting clinical study of the patient, plus a critical analysis of such x-ray work as one is entitled to do. In order that the most advantageous type of management may be selected, the completed diagnosis should include the level of the intestinal tract involved, the type, the cause, the duration, and the complications.

The strangulation obstructions constitute surgical emergencies regardless of the stage of the obstruction. Intubation as a postoperative procedure is a valuable adjunct to the management.

Organic obstruction in which the vascu-

larity of the bowel wall is not embarrassed may be individualized as follows from the standpoint of management:

1. Obstruction occurring in the immediate postoperative period, usually associated with some degree of peritonitis, is best managed by intubation. In many cases the obstruction will subside without further intervention.
2. Obstruction occurring months or years after intra-abdominal surgery or on other bases not associated with intra-abdominal inflammatory process may be managed (1) early in the process of developing distention, safely by immediate operation with intent to release the obstruction, and (2) late in the process of developing distention by intubation decompression until the distention has been controlled. Surgery can profitably be deferred until the patient has been rehabilitated.

Adynamic ileus is best managed by intubation decompression.

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## MYOMETRIAL MOBILIZATION

FRED. A. KASSEBOHM, M.D.

Director of Obstetrics, The Harlem and Lutheran  
Hospitals

AND

MILTON J. SCHREIBER, M.D.

Associate Obstetrician, Harlem Hospital; Assistant  
Obstetrician, The Lutheran Hospital

NEW YORK, NEW YORK

LABOR in the primigravida requires sixteen to eighteen hours for completion. Labor in the multipara is approximately six hours shorter. These time estimates are reasonable averages of the reports of various authors and they conform very closely to figures we arrived at in a study of 1,000 cases at the Lutheran Hospital of Manhattan. These averages apply only to labors terminating in spontaneous delivery. Indicated operative procedures are longer and elective operative procedures are somewhat shorter.

The duration of labor is under scrutiny here. In modern obstetrics, time consumption is limited to the first stage. Elective intervention at the beginning of the second stage can reduce it to any time period desired by the operator. The third stage is reducible to an insignificant time interval by the administration of ergotrate intravenously when the vertex crowns. Time is important in labor because prolongation of labor multiplies complications. The labor not completed in eighteen hours bears the threats of hemorrhage, exhaustion and fetal mortality. In such a labor or any labor, the advantages of shortening the first stage are obvious. There are unanswered questions concerning the first stage of labor.

At the onset of parturition in the usual primigravida, the presenting part is engaged (this does not apply to breeches) and the cervix is completely or almost completely effaced. The normal mechanism will require from fourteen to sixteen hours to dilate the cervix completely. What is happening in that time period?

The patient reports the onset of labor when she experiences *painful* uterine contractions. An intelligent patient notes

*painless* uterine contractions early in her pregnancy. These are the Braxton-Hicks contractions and they are palpable by the examining hand as early as the fifth month of gestation. They are brief, irregular in rhythm and the myometrial reaction responsible for them is mild. When painful contractions first appear, *pain* is the element which differentiates between Braxton-Hicks contractions and the contractions of early labor. The early contractions are weak, irregular and the myometrial reaction (as determined by the examining hand) is mild. As the first stage progresses, the contractions gradually assume certain characteristics: rhythm, prolongation, severity of pain, increasing frequency. The hand of the examiner notes an objective difference. While the early contractions produce only a moderate firmness in the myometrium, the later contractions produce a ligneous fundus at the acme of contraction which gradually relaxes as the pain recedes. When the contractions are rhythmic and are recurring at four to five minute intervals, persisting for forty to sixty seconds, labor is said to be established. Correlating early contractions against the behavior of the cervix as determined by examination, it is apparent that the early contractions have no effect on dilatation. The cervix begins to open when the contractions of established labor begin. It is a well recognized fact that labor may be hours old before cervical dilation is apparent. Between the onset of pains and the establishment of labor many hours may elapse. In this series of cases the actual time period averaged 6.5 hours. This is almost half the length of the average first stage. These hours can be looked upon only as wasted.

We interpret these facts in this manner: early labor is marked by contractions produced by only a small proportion of the myometrial potential. As labor progresses more and more of the muscle comes into play; in spontaneous delivery the full myometrial effort combines with the voluntary efforts to effect the expulsion of the baby.

Is it possible to bring the total myometrium into play early in labor? What means are available to do this? How would such mobilization of the myometrium affect the duration of labor? Would it be possible to eliminate the wasted hours during which the myometrium is exhibiting inefficiency? Reduction of the length of labor by 6.5 hours certainly, if possible within the bounds of safety, would be a salutary measure.

Several years ago, on the service of the senior author at a large city hospital, it was our misfortune to be faced with almost twenty-four cases of abruptio placentae and severe pre-eclampsia over a very short time. The patients with accidental separation were treated by the accepted conservative means: rupture of the membranes and repeated 2 minim doses of pituitrin at twenty minute intervals. We varied from this only in that we continued the dosage of pituitrin until the cervix was fully dilated. It occurred to us that we were really inducing labor in these patients and the procedure was so satisfactory that we applied exactly the same procedure to the pre-eclamptic patients whose condition indicated terminating of the pregnancy.

In the analysis of this small group of patients, one fact stood out, i.e., *the time period for the establishment of labor was extraordinarily brief*, at most two hours. Following mechanical rupture of the membranes and the immediate administration of pituitrin, clonic contractions at brief intervals occurred and continued to occur. The first stage of labor averaged 5.5 to 6 hours. In these cases we followed cervical behavior by examination. We gained the

impression that rupture of the membranes and administration of pituitrin actually mobilized the full potential of the myometrium.

The observations and impressions gained suggested that perhaps there was a safe technic for shortening the first stage of labor. Since intervention to eliminate the second stage has been safely employed for many years and since the third stage can be reduced to insignificance as above described, perhaps combining all of these methods might enable us to reduce sharply the duration of labor.

With these concepts in mind we decided to venture upon a large series of cases to test out the apparent theorizing. We had first to dispose of two well implanted obstetrical myths: first the inordinate fear of dry labor and second the unfounded aversion to the use of oxytocic drugs in the first stage of labor.

It has for long been apparent that dry labor has been misinterpreted and misunderstood. There is a wealth of evidence to indicate that the intact amniotic sac has been too much emphasized and conceded vastly more importance than it deserves. It may be stated that at the onset of labor with the presenting part engaged, *the intact membranes have no function*. The engaged presenting part prevents prolapse of the cord which is the only significant complication of rupture of the membranes. Rarely after rupture occurs does the uterus become completely drained of fluid. There is no dystocia co-incident with fluid loss. The dilating wedge of forewaters all too often does not exist. Examination will indicate that there are no forewaters between the presenting part and the membranes in many cases in which dilation proceeds rapidly. In other instances the membranes assume the shape of a watch crystal and palpation during a contraction does not reveal any bulge of the membranes against the cervix. Dilatation is the corollary of strong myometrial contraction. It is notable that the most certain method of inducing labor consists of rupturing the

nembranes followed by repeated doses of pituitrin. It is notable, too, that in the established labor, rupture of the membranes increases the frequency and intensity of the contractions. All too often at the end of a "dry labor," a fine gush of hind-waters follows the baby. Rupture of the membranes is not calamitous. As a matter of fact such an event increases the myometrial efficiency.

The use of oxytocics in the first stage of labor or for that matter *during any stage of labor* is, of course, the bête noir of obstetric conservatism. Pituitrin has been blamed for much and is guilty of little. Like every other therapeutic innovation it was heartily misused and on the memory of early misuse and the accidents concomitant, it has been condemned roundly and loudly. But it must be remembered, too, that the early preparations were of uncertain potency and without standardization, that unbelievable dosage was used and that often it was used when only contraindications existed.

Pituitrin has been held culpable for many ruptures of the uterus and there is no question that it has been the etiologic factor in that accident on occasion. But the incontrovertible fact is that *the commonest cause of rupture of the uterus is internal podalic version*. Shall we discard version because accidents occur? Pituitrin is accused in the literature of producing uterine tetany after the administration of 1 minim. We would have to have considerable qualification and clarification before we could give credence to such accusation.

Pituitrin has long been used in an accepted method of inducing labor (which method fails incidently in 60 per cent of cases because the membranes are intact). Pituitrin in small, divided dosage is standard therapy in the management of accidental separation of the normally implanted placenta. If it is freely employed in the induction of labor and without compunction in the crippled myometrium of *ablatio placentae*, why the fear of its use

in the normal myometrium during the first stage of labor?

Labor, eminent authors to the contrary, is no pleasant interlude. Labor pain is no weird psychic machination of an unstable nervous system. Labor is painful and psychotherapy does not stop the pain. The shorter the labor, the less the pain; the less the ordeal of the mother and the less the trauma to the infant; the fewer the complications attached to the labor which reaches to or exceeds eighteen hours.

We attempted to reduce time consumption in labor in a fairly large series of cases according to the following plans. In them we routinely used oxytocics in the first stage. In patients seen early in labor or in whom labor was induced, we employed pituitrin. In patients seen after the onset of labor with cervical dilatation at a minimum of 4 to 5 cm. we used thymophysin. It differs from pituitrin in that it produces a contraction marked by a rapid increment to a prolonged acme and a gradual decrement. The contractions produced by thymophysin are considerably longer than normal or pituitrin contractions. Even relatively large doses of pituitrin do not produce similar myometrial reaction. Thymophysin must be used with extreme caution and patients must be carefully observed.

#### TECHNIQUE OF MANAGEMENT

*Patients in Whom Labor Was Induced or in Whom Cervical Dilatation Was Less than 3 Cm.* These patients were instructed to report to the hospital promptly upon the appearance of: (1) pain, (2) bleeding, (3) rupture of the membranes. It might be stated that to avoid the appearance of shifting responsibility, all patients were private cases.

Immediately upon admission, the obstetric field was shaved and mechanically cleansed with green soap and water and flushed with Lysol solution. Examination under aseptic precautions was performed and the membranes were ruptured provided: (1) the presenting part was at the

level of the ischial spines and (2) cervical effacement was so advanced that the cervix was 1.5 cm. or less in length. Immediately following the rupture of the membranes 2 minims of pituitrin were given followed by a hot soap suds enema. Two minim doses of pituitrin were repeated every twenty minutes until labor was established after which 1 minim was given until the cervix was fully dilated. Amnesia was produced with nembutal (a minimal dose of 6 gr.) and scopolamine gr.  $\frac{1}{200}$ , the latter repeated in forty-five minutes. Promptly upon full dilatation, delivery was effected either by forceps or breech extraction under anesthesia. Ergotrate, ampoule 1, was given intravenously before the body of the baby was delivered. The cord was promptly clamped and cut following which the placenta was expressed, usually by modified Crédé.

*Patients Seen in Labor with Cervical Dilatation at a Minimum of 4 to 5 Cm.* After the usual preparation, the membranes were ruptured and 4 minims of thymophysin were given subcutaneously. Delivery was promptly completed upon the occurrence of full dilatation and the third stage managed as described above. In multiparae in this group, labor usually proceeded with such rapidity that only gas-oxygen could be used for analgesia. In the primigravida, amnesia was produced as in the above group.

These technics have been carried out in a total of 565 cases. Three hundred and sixty-seven fell into the first group and 198 in the second. Returning to the charts to analyze the results we found sufficient data for study in 450 cases. The results in them are stated below.

We are aware of the fact that this is radical management but it has been carried out, not in any attempt at sensationalism but to prove a position. We have maintained that posterior pituitary and thymophysin can be used to great advantage in many obstetric situations, i.e., induction of labor, ablatio placentae, primary and secondary uterine inertia, and to speed

the completion of the first stage. In this series we have safely used the drugs in that situation in which they are supposed to be most dangerous. In reasonable dosage there is no danger. In our experience we have seen no difficulties or complications in the short labor. As labor passes the eighteenth hour, problems and complications arise. Since there is no known means of predicting the duration of labor, we believe that any method which will guarantee that labor will be complete in less than that time can only be of value. There are other factors: Pain relief is far simpler in the short labor and amnesia is more effective. Hemorrhage is unknown; the myometrium is never so exhausted that it cannot accomplish contraction and retraction after the placenta is expressed. The general status of the patient is better. Maternal exhaustion is never met and the baby is spared the prolonged trauma of prolonged labor.

#### DETAILS OF MANAGEMENT

*Rupture of the Membranes.* This was performed in all the cases regardless of dilatation. The only requisite was cervical effacement or partial effacement so that the length of the cervix was 1.5 cm. or less. We use an ordinary, steel knitting needle which is guided along the examining fingers to the membranes. After perforating the sac the opening is extended with the fingers. Escape of fluid is the only certain sign that rupture has been effected. Occasionally, it is necessary to displace the presenting part upward slightly to permit the escape of amniotic fluid. This is especially essential in those instances, commonly enough encountered, in which there is little or no forewater.

*Dosage of Pituitary.* Dosage has varied from 1 minim every twenty minutes to 6 minims at the same time intervals. We finally decided upon a 2 minim dose because we found no clinical difference in the myometrial reaction to 2 or 4 minim doses. Six minims might cause accidents although we have never seen any. Once

labor has been established the dosage is reduced to 1 minim every twenty minutes. This is continued until the cervix is fully dilated. We have used as much as 7 minims of thymophysin in a single dose but this is not recommended. A four minim dosage is effective and safe.

**Amnesia.** After considerable experimentation with various technics designed to produce analgesia, i.e., Gwathmey, para-dalyde, evipal, seconal, sodium amytal, morphine and scopolamine, avertin, etc., we are convinced that there is no satisfactory method of producing analgesia throughout the first stage. We seek to produce amnesia and the best drug combination we know is nembutal and scopolamine. To be effective the dose of nembutal must be large and certainly never less than 6 gr. Scopolamine should be given in two doses of gr.  $\frac{1}{2}$  with a forty-five-minute interval between them. The first dose of scopolamine is given with the nembutal. In the short labors in this series we have never repeated either drug. When the cervix is fully dilated, inhalations of ether should be begun before the patient is moved from the labor room. Many patients are able to recall being transferred from bed to a stretcher. This memory is obliterated by the inhalations of ether.

#### CLINICAL DATA

**Cases Seen Early in Labor or Induced.** The total number was 300. The youngest patient was nineteen, the oldest thirty-seven. All were at term: ninety-four were induced labors; 206 were in early labor; 192 were primigravida, 108 were multigravida. Examination was done throughout the labors. The maximum number of examinations in one labor was eleven, the minimum number four. In no instance was cervical dilatation above 3 cm. at the time of rupture of the membranes. The average time interval from rupture of the membranes to the establishment of labor was 1.7 hours; the average duration of the first stage was 6.2 hours. The second stage was terminated by forceps in 291 cases and by

breech extraction in nine. The longest second stage was twenty-five minutes. The average third stage was five minutes. There were 299 live births. The still birth was proved to be an erythroblastosis at autopsy. There was one neonatal death proved to be due to rupture of a pleural bleb and spontaneous pneumothorax. The pneumothorax was diagnosed by x-ray after death. There were no maternal mortalities. Morbidity was 2.9 per cent (standard of the American College of Surgeons). More significant than morbidity determined by an arbitrary temperature reaction is the fact that only one patient required more than the usual ten-day period of hospitalization. She was discharged on the fourteenth postpartum day. There was no cervical laceration and no postpartum hemorrhage. The shortest labor (multipara) was one hour and five minutes. The longest labor occurred in a multipara and lasted sixteen hours.

The largest dose of pituitrin was 128 minims in thirty-two doses. The smallest dose was 4 minims in two doses. The average dose was 20 minims divided into twelve doses. Anesthesia for operative delivery was ether by the open drop method.

**Cases Seen in Labor with Minimum Cervical Dilatation of 4 to 5 Cm.** These totalled 150. The youngest patient was eighteen, the oldest thirty-nine; 109 were multipara and forty-one were primigravida. The maximum dilatation acceptable for this group was 5 cm. The average duration of labor at the time patients were seen in the hospital was 4.7 hours. Membranes were ruptured mechanically in 112. Spontaneous rupture had occurred in thirty-eight. The dosage of thymophysin was 4 minimis. This dose was repeated only four times. The maximum dose was 8 minims in two doses. The average duration of the first stage after one dose of thymophysin was fifty-four minutes; the average duration of labor was 8.9 hours. The longest labor lasted eleven hours, the shortest labor 2.2 hours. Examination was performed throughout. The maximum num-

ber of examinations was nine, the minimum three. There were 147 forceps deliveries and three breech extractions. No still births or neonatal deaths occurred and there was no maternal mortality. Morbidity was 4.9 per cent. The longest period of hospitalization was twelve days and there were no cervical lacerations. Gas-oxygen was used for analgesia in ninety-seven cases, nembutal and scopolamine for amnesia in 53. There was no instance of postpartum hemorrhage.

#### BEHAVIOR OF THE NEWBORN

Three hundred and twenty-seven patients received nembutal and scopolamine. To the respiratory depressing (?) potential of these drugs must be added the depressing effect of ether. Despite this potential threat there was no alarming delay in the onset of respiration and no vigorous methods of resuscitation were required. These babies *did not* cry lustily immediately at birth as babies delivered spontaneously so often do. They exhibited no true apnea. As a rule, a shallow respiratory effort was established immediately and by the time the cord was tied color was good and mild stimulation (rubbing the skin with a dry towel) elicited lusty crying. We have never encountered profound depression of respiration after the use of nembutal and scopolamine as described.

#### REMARKS

This study has enabled us to make certain side observations. It is obvious that the use of pituitary throughout the first stage will terminate that stage far in advance of the ability of the normal mechanism. It is obvious, too, that there is no danger associated with the method. It must be noted that the stimulation of pituitary is transient. This was very apparent in cases in which we withdrew the drug after one or two doses. In such instances labor either ceased or became desultory. There is a synergism between ruptured membranes and pituitary. With

the membranes intact we have seen as many as twenty-eight four-minim doses produce absolutely nothing more than irregular mild cramps. In this same patient active labor followed rupture of the membranes and the second two-minim dose. The implication here is that where induction of labor is indicated, *the membranes must be ruptured* and pituitary administered. This will never fail within four weeks of term if the pituitary is continued in small dosage until labor is established. Once established, dosage may be reduced but should be continued until full dilatation is present.

This method is more certain and more preferable than the introduction of a bag or bougie, particularly if these foreign bodies are extra-ovular as is the fashion with certain operators.

Yet another implication here is the almost unexplored field of pituitary in uterine inertia. There have been cautious references to its use in the literature but the commoner method of management of inertia is morphine and fluids. It is an unfortunate truth that much of what is called inertia is only prolonged false labor, in which the constant nagging, futile pains produce only exhaustion. Such patients can be quickly thrown into good, active labor by small repeated doses of pituitary. We believe this is preferable to the further delay incident to the administration of morphine. In true secondary inertia pituitary is remarkable in its efficacy. In this situation it will rapidly put the myometrium to its appointed task but here it must be used in 1 minim doses with much caution. Where labor has ceased, there is no regression in the thinning of the lower segment and violent contractions may well produce rupture. Hence the dosage should never exceed 1 minim and the time interval between doses should never be less than twenty minutes.

While not contraindicated in prolonged labor, again much caution must be employed if the myometrium is to be stimulated with pituitary. In such cases the

lower segment, thinned and tenuous, will not tolerate undue stress.

We believe that pituitary is contraindicated when the cervix is fully dilated and advance has ceased. It is as much contraindicated in such circumstance as when insuperable pelvic contraction exists. In fact insuperable pelvic contraction and cessation of advance after full dilatation may be much the same thing. When full dilatation exists and good contractions are occurring advance must follow, or the equivalent of insuperable contraction may, in a sense, be said to exist. Failure of contractions may represent myometrial exhaustion. After full dilatation, pituitary must never be used as a substitute for operative delivery. It is exactly in such cases that uterine rupture may occur.

The morbidity in this series is low. It is not the examination gently performed under aseptic precautions that results in morbidity. It is the traumatizing, careless examination plus subsequent blood loss and we are inclined to the belief that the blood loss is the more important factor.

The low morbidity serves to indicate the value of mechanical cleansing with soap and water long taught by Moorhead in traumatic surgery. Mechanical cleansing and copious flushing of the operative field during delivery, gentleness in examination, exquisite handling of tissue in repair of perineotomy, these are the factors contributing to lower morbidity. The paramount factor is the control of blood loss.

**Disadvantages.** The methods are, primarily, limited. They cannot be employed in those cases in which the presenting part is unengaged since rupture of the membranes invites prolapsus funis. They should not be employed when cervical effacement is not begun or when the cervix is longer than 1.5 cm. They must not be employed

when the pelvic capacity and architecture are not thoroughly understood.

Patients carried under these régimes require observation, not because of possible accidents but because operative intervention must be timed properly. There is no point in reducing the length of the first stage if the exact time of full dilatation is not known. It is ridiculous to judge of full dilatation from the occurrence of the reflex bearing down pains. Hours may elapse between the occurrence of full dilatation and the beginning of such pains. Patients must be followed closely and frequently examined if the full value of the régime is to be obtained. This is wearing and time consuming. Yet the results as stated in numbers and the happy reactions of the patients make the energy expenditure worth while.

#### CONCLUSIONS

Pituitary has been used routinely in the first stage of labor in conjunction with rupture of the membranes in 367 cases without complication or accident.

In small doses at twenty-minute intervals it is an effective, safe agent with which time consumption may be reduced.

Thymophysin has been similarly used in 198 cases with identical results.

These agents are to be respected and not feared.

Duration of labor can be reduced to approximately eight hours during which time absolute amnesia is obtainable in 95 per cent of cases.

Contraindications to pituitary are discussed.

The limitations and disadvantages of the methods are outlined.

The use of pituitrin to induce labor, prevent false labor and to overcome secondary inertia is suggested.



# MAJOR RESECTION FOR FUNCTIONAL GASTROINTESTINAL DISEASE

## REPORT AND EVALUATION OF TWO CASES

ALEXANDER STRELINGER, M.D.

ELIZABETH, NEW JERSEY

RETROSPECTION on the history of medicine reveals many conditions, the cause of which at first was misunderstood, but gradually, at times through trial and error method it was identified. Such were malaria, thought at one time to be a miasmatic disease, and tabes which was once described as metasyphilitic. Cure of the disease by various methods was attempted before the true nature of it became known. In some instances the better knowledge of the disease proved that the empirically used treatment was correct. Instances of this were quinine for the treatment of malaria, and mercury for the treatment of syphilis. The identification of the cause was often delayed even when the research worker located it. Thus it happened, that Pettenkoffer drank a culture of cholera bacilli and did not contact cholera. This, for a while, made doubtful that Koch really identified the pathogenic bacterium of cholera.

The trial and error method continues in many phases of medicine. At times progress starts by the realization and admission that the cause of a disease or of a disease group is not well understood. Martin<sup>1</sup> states: "Twenty years ago it was smart medicine to say, 'If the doctor can not find an organic cause for the patient's symptoms, that is recognition that he has not looked far enough!' This indictment of the examiner was tempered however by the realization and admission that medical knowledge had not yet progressed sufficiently, and even the best doctors were not expected to understand the basis of symptoms, the cause of which had yet to be successfully investigated and explained."

A number of so-called functional diseases of the gastrointestinal tract were found to be of psychogenic nature. Constitutional evidences associated with psychoneurosis, also evidences of vasomotor instability, as described by Martin<sup>1</sup> are helpful in making the diagnosis.

### Martin's Criteria

#### 1. Certain constitutional evidence associated with psychoneurosis:

- A. Poorly developed body
- B. Narrow chest and narrow costal angle
- C. Flaring hips
- D. Marked lumbar lordosis and visceroptosis

#### 2. Evidence of vasomotor instability:

- A. Flushing
- B. Sweating
- C. Cold, clammy hands and feet
- D. Over labile blood pressure
- E. Paroxysmal tachycardia.

Martin uses the term of psychoneurosis in a broad sense: ". . . it is meant to signify that the symptoms, from which the patient suffers, are due to an imbalance of the vegetative nervous system. The imbalance is produced in turn through the intervention of the cerebrum and its interpretation of sense perceptions." The definition of Jewett,<sup>2</sup> who evaluates the gastrointestinal neuroses in terms of the psychobiological unity, is similar. The basis of such disturbances, according to him, rests upon emotional excitations of the subcortical centers and their conduction through the

sympathetic and parasympathetic pathways to the gastrointestinal tract. He stresses that, when considering gastrointestinal neurosis, organic disease must be excluded, and enumerates symptoms that would indicate it: continued abdominal pain, persistent hyperacidity when associated with pain and heartburn, gastric pain associated with subacidity, vomiting or retention, the presence of macroscopic or microscopic blood in stool or vomitus unless definitely explained by some other factor, and the presence of profound anemia. Eppinger and Hess<sup>3</sup> run a close third with their definition: "Functional gastrointestinal disorders are caused by sympathetic and parasympathetic imbalance." The word "functional" is embodied in this definition.

Instances of gastrointestinal invalidism caused by psychic mechanism have been numerously reported in the literature. It can be stated that the gastroenterologist with an eye on the psychic mechanism often will suspect the true nature of the patient's complaints, when at the same time the exclusively organic minded examiner fails.

The idea of psychoneurotic pathogenicity became so well entrenched in gastroenterology, that, broadly speaking, two groups have been established among the causes of gastrointestinal disease: (1) organic, (2) psychoneurotic. Thus all diseases that were not organic, were cast upon psychoneurotic waters. But the word and concept of "functional" disease still lurked in the offing. Bergmann<sup>4</sup> described a number of conditions, the true nature of which lacked understanding. He emphasized that this may be due less to poor conception than to incomplete or inefficient methods for examination of function in which changes in form are absent. He showed that critical evaluation of infrequently used laboratory methods, experimental approach or unconventional reasoning permits postulation of disease entities not known by routine examination. From the many subjects discussed by

him, chronic pancreatitis and dyskinesia of the extrahepatic bile ducts should be mentioned as examples of gastrointestinal disturbances that for the time being cannot be fitted into either the organic or the psychoneurotic group. The division between the basic states, organic, psychoneurotic and functional, may be difficult. Routine examining methods may not disclose organic causes for pylorospasm. But Hölsti<sup>5</sup> found histological evidence of inflammatory changes in the cells of the plexus myogastricus situated in the deeper mucosal and muscular layers in some of these conditions. This finding takes the case out of the realm of functional and places it into the organic group. Similar in nature in Rossle's<sup>6</sup> finding of neuromata in otherwise normal appendices. On the other hand, achylia or hypersecretion may formerly have been accepted by some as organic just because definite figures could be attached to them. Conditions of this sort are not well understood. To achieve this it will be necessary in the future to analyze their function and synthetize the clinico-functional-pathological entity. Martin's word regarding psychogenic gastroenterological afflictions may then be requoted, only "psychogenic" will be supplanted by one or more words representing new basic patterns.

Meanwhile, what shall the physician do when he meets a condition falling into the obscure category? "Nil nocere." This is easier said than done. For practical purpose it often has to be reduced to the formula: Choose the least evil among the many.

The following is the record of two cases, in which such reasoning in the treatment of "functional" gastrointestinal disease lead to partial resection of the stomach and resection of the ascending colon, respectively.

#### CASE REPORTS

CASE I. A female patient came under my observation on January 10, 1935. At that time she was thirty-four years old. Partly from her,

partly from the hospitals to be mentioned, the following history was obtained:

The patient took sick about twenty-one

diagnosis of gastric spasm, and chronic endometritis, respectively. Her condition did not improve. In February, 1932, she was examined

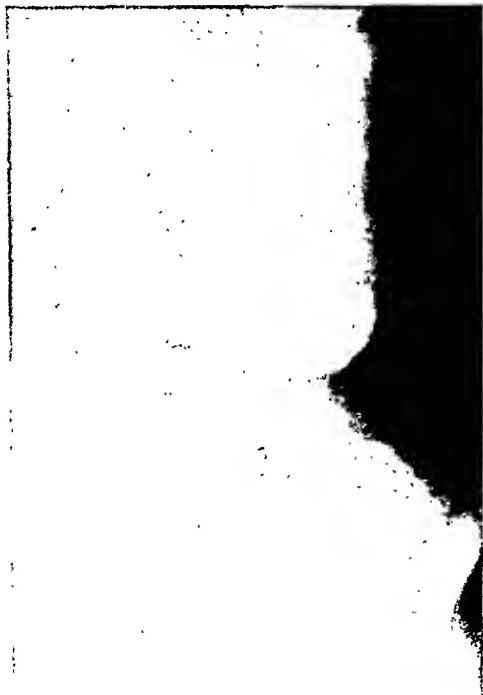


FIG. 1.  
FIGS. 1 AND 2. Case 1. Preoperative films taken February 9, 1935.

years ago, her symptoms consisting of nausea and pressure in the stomach region. This was continuous though varied in intensity. At that time she was single. On April 10, 1924, she was operated upon at the surgical service of the St. Marian Hospital in Muhleim-Ruhr, Germany. There was an ulcer found on the anterior surface of the duodenum near the pylorus. The pylorus was closed by Mertens's technic, the ulcer was sewn over, and a posterior retrocolic gastroenterostomy was done. After this operation the patient did not feel well. She continuously complained of feeling sick to the stomach, nauseousness, postprandial pain, and occasional vomiting. Various medical measures were tried. She was married and later on came to the United States.

In 1929 she was admitted to St. Barnabas Hospital in Newark, New Jersey, and a diagnosis of gastric hypermotility was made. In January, 1930, again at St. Barnabas Hospital, a cholecystectomy and an appendectomy were done. She was readmitted to the same hospital in May, 1930, and in June, 1931, with the

in the out-patient clinic of St. Elizabeth Hospital in Elizabeth, New Jersey and was subsequently treated there until September, 1933. Gastric lavages, insulin injections, diet, alkalies, and barbiturates produced relative improvement in the patient's condition around the beginning of the summer 1933. In spite of continued medical efforts this improvement ceased after two months' duration.

Her complaints continued, though her condition was tolerable. In January, 1935, she felt worse and nausea and vomiting occurred frequently. She also had violent attacks of postprandial pain and at times pain on an empty stomach. Pureed vegetables, apple sauce, and raw apples were the best tolerable foods. On examination in January, 1935, her face showed a poor color; the heart and abdominal organs physically were essentially negative. Scars of the former operations were visible; tenderness was found in the epigastric region. The blood pressure was 106 over 76. A fractional gastric analysis showed bile in all fractions. The free acid ranged from 0 to 16;



the total acidity from 11 to 32. The stools were positive for occult blood. X-ray examination of the gastrointestinal tract showed a fishhook

radiological examination of the stomach was repeated with identical results. Examination of the stools for occult blood twice gave positive



FIG. 3.  
FIGS. 3 AND 4. Case 1. Preoperative films taken on March 3, 1935.

shaped stomach with good contours in the oral part. A well functioning gastroenterostomy was seen; the afferent loop could be filled by pressure for a short distance; the efferent loop filled readily; the emptying of the stomach through the gastroenterostomy was quick. To the right of the gastroenterostomy the aboral part of the stomach was visible. It filled readily. There was a vigorous, deeply cutting, irregular peristalsis on this part, the waves sweeping toward the aboral end of the stomach. At no time was emptying through the pylorus observed. The general appearance of this part was spastic, the contours were never quite normal looking. It was believed that the spasm and the hyperperistalsis were caused by some pathological condition; the presence of occult blood in the stools indicated ulceration of this part of the stomach.

From January 12, 1935, to March 25, 1935, the patient was treated medically. Diet, alkalis, and feeding through the gastroenterostomy by tube were ineffective. Most of this time the patient was in bed; repeatedly it was necessary to give morphine by injection. The



FIG. 4.

results and once a negative result. The patient's general condition got worse; the pain was steady and intense, and the patient's mental attitude became desperate.

She was admitted on March 25, 1935 to St. Elizabeth Hospital, Elizabeth, New Jersey, for the purpose of operative treatment. On March 27, 1935, she was operated upon with the preoperative diagnosis of probable ulcer in the distal one-third of the stomach. The abdominal cavity was opened under novocain field anesthesia and splanchnic anesthesia was induced. The adhesions in the upper part of the abdomen were freed to allow inspection and handling of the stomach. The entire body of the stomach appeared to be soft walled and of normal consistency; the site of the gastroenterostomy appeared free of disorders, the stoma adequately wide. The stomach continued down to the duodenum with a continuous lumen.

In view of these findings the patient's complaints, her desperate attitude, the physical and x-ray findings were considered. It seemed that the x-ray findings—no passage through

the pylorus that was organically open, and intense spasm on the distal one-third of the stomach—indicated serious functional dis-

and lymphocytes. The submucosa, muscularis and serosa are free and clear."

The patient rallied well after the operation,



FIG. 5.

Figs. 5 AND 6. Postoperative films taken on April 19, 1935. They show that the blind stomach stump and the anastomosis are shifted more to the right, than they were pre-operatively. Figure 6 shows well that the stoma is wide and the emptying sufficient, also that spasm is absent.

turbance of the distal one-third of the stomach and of the pylorus. Resection of these parts was decided upon.

The operation was continued by resecting the stomach from the gastroenterostomy down to the duodenum and closing the stomach and the duodenum stump by inversion and by Lambert sutures. The gastroenterostomy itself was preserved. The patient received 500 cc. of blood postoperatively.

Dr. Casilli examined the resected stomach segment and reported the following: "Partial resection of the stomach 9 cm. long. There appears to be no anatomical mark to identify the pylorus. The external surface shows a bluish, slightly echymotic serosa, to which tags of fat are adherent. From this surface there is a linear depression which might be taken as the pyloric ring. The mucosa is light yellow in color. The folds are normally distributed, but appear to be slightly thickened. M.E.: The mucosa shows superficial erosions. The tunica propria is slightly edematous, and contains the usual plasma cells, eosinophiles,

and had an uneventful recovery. The post-operative x-ray control showed a well functioning gastroenterostomy, and no particular abnormalities on the remaining stomach.

The clinical condition of the patient improved considerably and has remained improved for eight years postoperatively as indicated by the following: The abdominal pain ceased completely. The patient's sleep, very poor preoperatively, is sound and refreshing. The constipation, present for many years preoperatively, ceased. Her appetite at times is poor but generally good. Several periods occurred, during which a sick feeling to the stomach was present, but it was always controlled by stomach lavages. Her headaches continued until 1938, when a vaginal hysterectomy was done; thereafter they ceased. The general condition throughout the years postoperatively was much better than during any period of even a few weeks in the years between the first operation and the partial gastric resection.

The pathological disorders leading to the preoperative complaints cannot be well classi-



FIG. 6.

fied: it was a functional disease, upsetting the neuromuscular balance of a part of the stomach and of the pylorus, causing intense spasm.

CASE 11. A female patient, thirty-eight years old, was first examined on October 4, 1941. She gave the following history: She was married and had three children with no miscarriages. She had had rheumatism as a child, scarlet fever at the age of twenty-one, appendicitis at the age of twenty-four. Her main complaint was persistent pain in the right lower quadrant. Her periods, usually normal and on time, became very painful in 1937. Since that same time pain was present in the right lower quadrant, this being fairly constant. In January, 1939, a physician made the diagnosis of cyst of the right ovary. In January and in March, 1939, she was subjected to two laparotomies, in the course of which two tubes and one ovary was removed. Following the second operation thrombophlebitis of the left leg set in which improved gradually. The right lower quadrant pain persisted; from July, 1939, she was treated by another physician for adhesions. In 1941, she was hospitalized again; the "rest of the ovary" and the uterus were removed. Following this operation she was improved for approximately six months, though the right lower quadrant pain persisted to a lesser extent; in July, 1941, it increased in intensity. This pain, with varying intensity, was present all the time. During the week preceding the first examination the pain was extremely sharp; it radiated into the back and into the right thigh. Her appetite was diminished by the pain and she was constipated. Coincidentally with walking and bowel movements the pain increased. There was no nausea, nor any urinary frequency.

Examination on October 4, 1941, and on subsequent dates showed that the patient was fairly well nourished. Physical examination disclosed moderate tenderness in the epigastric region, in the right upper quadrant, and in the lower lumbar region. There was very marked tenderness in the right lower quadrant. No masses were felt. Her tonsils had been removed and the uterus including the cervix was also removed. The parametrial regions were not painful on pressure. Urine analysis was essentially negative. Analysis of the blood showed moderate secondary anemia with 4 per cent stab cells; otherwise it was essentially negative. In the fecal matter there was absence of undi-

gested elements, inflammatory elements, ova, or ameba; there was occult blood three plus on one instance and negative on two other occasions. Intravenous pyelogram produced good visualization of both pelvis, all calices and both ureters; there were no abnormal features. A gallbladder series produced good visualization and good contraction. During a barium enema, barium entered the terminal ileum; the colon tract showed no abnormal features. The emptying film showed considerable residue in the whole colon tract. A gastrointestinal series and later on a series for small intestinal detail showed no abnormal features.

While the examination was in progress, the patient was kept on smooth diet, belladonna and mucilose. She spent the greater part of the day in bed. The pain persisted with varying intensity. On October 29, 1941, the pain became very intense while moving the bowels; after the movement a large amount of red, partly clotted blood was discharged by rectum. On October 31, 1941, the bleeding re-occurred under similar conditions. It was verified that the fecal matter was intimately mixed with blood, and that free blood followed the fecal matter. The patient was hospitalized at St. Elizabeth Hospital. Proctoscopy was done on the following day; the scope was inserted for a length of 6 inches; there was no source of bleeding found on this length.

The location of the pain and the intestinal bleeding indicated that the pain was connected with the right colon. The absence of any pathological condition by barium enema and the negative features of the examination of the fecal matter suggested that any possible disturbance in the right colon was of some unusual nature. The patient suffered much and repeatedly required morphine.

She was seen in consultation by Dr. Casilli, Dr. Gerendasy, and Dr. Tator. Dr. Casilli suggested that malignant degeneration of a polyp on the basis of polyposis of the colon might be present; as further probabilities he mentioned a bleeding Meckel's diverticulum and simple adhesions. Dr. Gerendasy and Dr. Tator did not make a probable diagnosis. All three consultants believed that exploration was indicated.

On November 10, 1941, the patient was operated upon and laparotomy was done. Except for numerous adhesions, particularly dense around the right colon, no definite

disorder was found, though the entire length of the small and of the large intestinal tract was examined. Some uncertainty was experienced about a possible disturbance in the ascending colon, that might be identified if dense adhesions were absent.

Even though the operative exploration, inspection, and a palpation of the large intestines did not disclose any disorder, a normal colon would not bleed. This fact was accepted as evidence of some pathological condition in the large intestinal tract in the painful area, the ascending colon.

Resection of the ascending colon and side-to-side ileotransversostomy was done with closure of the abdomen. Pathological and histological examination of the resected terminal ileum and of the ascending colon did not identify any disorder.

The convalescence of the patient started with moderate shock that was controlled by transfusion. On the third postoperative day the incision opened and pus and fecal matter were discharged. This was the beginning of a fecal fistula; several months later it had to be closed operatively. Except for these complications the postoperative course was undisturbed.

About sixteen months have passed since the last operation. The patient is relieved of the right lower quadrant pain. Her persistent constipation is considerably lessened and she has a normal bowel movement nearly every day. Her appetite is good. There is no recurrence of the intestinal bleeding. She does her housework and in addition to this for the last six weeks she has also been doing factory work. While the time elapsed since the operation is not too long, it is much longer than the period following the third operation upon this patient, during which she had only partial relief and otherwise no relief for four years preceding the right colon resection.

Both cases are unusual. It is understood that only conditions of more or less obscurity are considered here. Under such circumstances it becomes imperative to exhaust all means of medical treatment; the physician must register failure by such means, before any operative treatment can be considered. Following this, psychoneurosis must be definitely excluded. Martin's criteria may be found helpful. Applying them to the first case

I am compelled to say that the patient presented features suggesting psychic elements. This did not enter into the decision for resection because the x-ray findings indicated a disturbance in the distal stomach pouch and this was naturally considered organic. On operation, however, the grossly non-organic nature of the disease was revealed. The decision for resection was made with the patient under an anesthetic and with an open abdomen. Cases of intense spasm are reported, and some of them, for instance, the one cited by Granet,<sup>7</sup> are stated to have come about by psychoneurosis. Careful evaluation of these reports will fail to convince all readers uniformly of the psychoneurotic nature of the spasm. Very few instances of achalasia of the cardia proved definitely to be due to psychoneurosis. The same is true of biliary diskinesia. All this would, in retrospect tend to strengthen the argument in favor of resection which was done on the first patient. In the second case a possible absence of readily provable organic disease was considered preoperatively; the general make-up of the patient, her general attitude, build and appearance were such that psychoneurosis could be excluded with reasonable certainty. Applying to her Martin's criteria, this exclusion would be repeated.

After psychoneurosis is eliminated, the operative risk must be considered. This should be reasonable when measured by the degree of the patient's suffering. The first patient was desperate. It was thought that there was an ulcer in the spastic stomach pouch. She was willing to subject herself to any operative procedure that held out a reasonable promise for improvement. The second patient was suffering less. While she underwent three laparotomies to obtain relief, her suffering persisted and gross intestinal bleeding occurred. These facts established compliance with the rule suggested above.

If operative treatment is decided upon, the type and extent of it should be based on reasonable localization of the end

effect of the disorder, as has been described above. When this is possible, the logical step is the destruction of such localized end effect. This is the process in a sense when treating achalasia of the cardia; the end effect of the disturbance as we observe it, is muscle spasm of the cardia. Overstretching the muscle renders it incapable of further spasm. Thus the end effect is destroyed. In the two cases reported a part of an organ seemed to be the seat of the end effect and removal of the offending organ seemed to be the logical step. Quoting Bergmann<sup>4</sup> it becomes obvious that a type of major resection is practiced daily, based much on the same reasoning, though the reasoning is often forgotten or equally frequently suppressed from consciousness:

"What is the nature of the not all too satisfying gastritis and ulcer treatment of our day? Is it anything else but soothing of the mucosa, relaxation of the muscular layers by atropin, Glaubersalts or dilute silvernitrate spray, and the keeping away of further harm? Lest we treat the 'functio laesa,' not etiologically, but by medical attack on the pathological attitude of the organ or of the whole body, the primitive, crippling, extensive operation becomes unavoidable. Half of the stomach, or even more has to be removed, but the specimen will only reveal an ulcer of a few millimeters in diameter ahead or past the pyloric ring surrounded for good measure with inflammation in its very immediate neighbor-

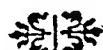
hood. The resection is functional therapy, because it removes parts of the 'stomach-duodenum,' which induces the generation of acid. This generation is one of the factors, which, much in contradiction to Konjetzny's postulates, is essential to produce an ulcer: it is the peptic factor. Therefore, whenever the primitive 'determinatology' of mucosal therapeutics lead to abysmal failure, the extensive resection to my mind is still the best treatment."

#### CONCLUSION

Under exceptional circumstances a major resection carrying considerable risk becomes justified for treatment of gastrointestinal disease of uncertain nature. Two cases are cited to illustrate this statement. An attempt is made to define specific criteria for such a procedure.

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# THEORY AND THERAPY OF SHOCK\*

## VARIED FLUID INJECTIONS

FREDERICK M. ALLEN, M.D.

NEW YORK, NEW YORK

**A**SIDE from experimental curiosity, the use of maximum saline infusions, as described in the preceding paper,\* was suggested by several considerations. With the syringe method, the animal improves visibly with each repetition of the large injections. When death from shock has been so imminent, there is an impulse toward panicky excesses of treatment. Theoretically, it was desirable to try overcompensation of the shock state, also a hypothetical toxin (or potassium) might be diluted in the mass of fluid and carried out in the flood of diuresis. These experiments constituted Group I in the investigation; but as the excessive fluid proved dangerous or fatal, it was natural to try quantitative and qualitative variations. Therefore Group II consisted of experiments with injections in reduced volume.

### MODERATE FLUID INFUSIONS

Dog 401 (Table I) had tourniquets on the hind legs for five and one-half hours, then received 1,800 cc. of saline intravenously during eleven hours. A small dose of morphine was incautiously given to quiet the animal shortly after removal of the tourniquets, and the unconsciousness† which came on with the shock may have delayed diuresis. More probably, however, the fluid was merely preempted by the rapidly swelling hind legs. The purpose in view was to check shock by giving just enough saline to prevent any marked hemoconcentration. This required the injection of 900 cc. in the first ninety minutes. Afterward the injections were spaced farther apart but nevertheless resulted in blood dilution. The progressively

severe fall in the red cell counts on the ensuing days might be attributed to anemia caused by the infections, but the profuse flow of arterial-looking blood whenever an ear vein was cut seemed to be a significant sign of hemodilution, supervolemia and vasodilatation. One assumption is that the plasma protein concentration was reduced and an abnormal state of equilibrium established between the plasma and the huge edema of the hind legs.

Thrombosis should never result from simple ligation of a dog's leg for five and one-half hours. The edema particularly of the right thigh was so exceptionally hard and board-like from the outset that it prevented discovery of the subsequent abscess, and the excessive pressure was probably the cause of the localized muscle necrosis. Enough food was digested to maintain a fair nutritive condition to the end. The length of survival amounts to a complete recovery from the otherwise surely fatal shock produced by the five and one-half-hour ligation.

Dog 403 (Table II) underwent ligation of both hind legs for five and one-fourth hours, followed by injection of 1,800 cc. of saline during four and three-fourths hours. This unusually short treatment sufficed to control hemoconcentration. Water was given only after the end of the injections and no record was kept of it. There was distinct depression during the acute stage and for several days afterward. It seems significant for the theory of shock that symptoms thus occurred in spite of control of hemoconcentration from the outset. Shock was prevented to a sufficient degree that the dog survived without apparent danger at any stage.

### COMMENTS

These injections are classed as moderate, though in human patients weighing ten times as much as the dogs they would correspond to 18 liters of saline given in about five to eleven hours. There is no record that any clinician ever adopted the

\* Am. J. Surg., 61: 79-92, 1943.

† Cf. Freedman and Kabat in addition to authors previously mentioned concerning dangers of anesthetics in shock.

\* From the Department of Physiology and Bio-chemistry, New York Medical College, New York City.

rule of controlling hemoconcentration in shock with saline injections regardless of quantity, up to one-fifth or one-fourth of

The wholly erroneous experimentation of the first World War has been an incubus upon shock studies ever since. Various

TABLE I  
DOG 401

Day of Experiment	Hour	Saline Cc.	Urine Cc.	Red Cells, Millions	Incidental Notes
1	8:30 A.M.	...	...	5.1	Nembutal 240 mg. intraper.
	8:50 A.M.	...	...	...	Morphine 20 mg. subcutaneous
	2:20 P.M.	...	...	5.3	Hind legs ligated; morphine 15 mg.
	2:50 P.M.	...	...	7.5	Tourniquets removed ( $5\frac{1}{2}$ hr.)
	2:50 to 3 P.M.	300			Restless; morphine 20 mg.
	3:20 P.M.	...	...	6.7	
	3:25 to 3:40 P.M.	300	...	...	Unconscious
	4:00 P.M.	...	...	7.1	Temp. 100°F., heart 180; resp. 24
	4:05 to 4:15 P.M.	300	...	...	Thigh swelling becoming large
	5:00 P.M.	...	...	6.2	
	5:05 to 5:15 P.M.	300	100	...	Barely able to sit up; drinks 120 cc. water
	5:40 P.M.	...	...	3.6	Ear blood becoming bright and profuse
	9:00 P.M.	...	...	6.0	Wags tail cheerfully; thigh swellings still increasing
2	1:30 A.M.	...	Lost	5.3	
	1:40 to 1:50 A.M.	300			
	1:50 A.M.	...	...	4.6	Good condition except for paralyzed edematous legs
3	10:30 A.M.	...	...	3.8	Strength still improving; temp. 100°F.
4	11:00 A.M.	...	...	2.6	Acts well but refuses food. Milk 200 cc. given by tube, retained.
5	5:00 P.M.	...	...	2.6	Edema diminishing; ear blood still thin, bright, profuse; fed forcibly
6	9:30 A.M.	...	...	2.2	Very profuse bright bleeding from ear; hind legs still huge; fed forcibly
7	4:00 P.M.	...	...	2.8	Specific gravity of 2 urine samples 1006 and 1008; eats a little meat voluntarily; temp. 102°F.; slight exertion causes dyspnea
8	2:00 P.M.	...	...	2.2	Specific gravity of 2 urine samples 1015; weaker; fed forcibly; blood bright; profuse
9	11:00 A.M.	...	...	4.1	Too weak to stand; temp. 86°F., urine specific gravity 1020; brief improvement in breathing.
	11:20 to 11:30 A.M.	300			Breathing and heart stopped simultaneously.
	11:40 A.M.				

Autopsy. Very large abscess with necrotic muscle in right thigh. Otherwise good condition of hind legs, with only slight edema remaining. Bronchopneumonia left lung. Other viscera negative.

the body weight within a few hours. The experience shows that at least in animals the "moderate" injections when begun early suffice to cure certain degrees of shock which would otherwise be fatal.

authors continue to report benefits from saline infusions (Abbott, Mellors and Muntwyler, Bourque, Haternis and Glassco), also Binet and Strumza recommend diluted blood and other writers favor diluted

serum or plasma. Bove and also Lindgren and Wilander advise laboratory analyses to govern injections of electrolyte or protein

injections. Theoretically also, hypoproteinemia has been unquestioned as a prime factor in the hemoconcentration of shock,

TABLE II  
DOG 403

Day of Experiment	Hour	Saline Cc.	Urine Cc.	Red Cells, Millions	Incidental Notes
1	6:00 P.M. 6:15 P.M. 10:00 P.M. 11:15 P.M. 11:30 P.M. 11:35 to 11:45 P.M.	... ... ... ... 300	... ... ... ... ... Lost	5.4 6.0	Nembutal 200 mg. intraper. Hind legs ligated. Nembutal 60 mg. Drowsy; temp. 95°F., tourniquets removed (5½ hr.)
2	1:00 A.M. 1:05 to 1:15 A.M. 2:30 A.M. 3:00 to 3:10 A.M. 4:50 to 5:00 A.M. 6:30 A.M. 6:50 to 7:00 A.M. 11:00 A.M. 4:00 P.M. 4:05 to 4:15 P.M.	... 300 ... 300 300 ... 300 ... ... 300	... 120 90 ... 50 ... ... ... ... ... Lost	6.5 7.5 5.1 ... 4.4 ... 4.8 5.5	Awake; temp. 99°F.; ear blood dark and scanty Slight diarrhea; temp. 102°F. (in very warm room) Struggling; morphine 10 mg. Lightly asleep Temp. 101°F. Eyelid edema; good condition; returned to cage Temp. 103°F.; ear blood bright, profuse
3	11:30 A.M. 9:00 P.M.	... ...	... ...	4.3 4.6	Temp. 101°F.; walks in spite of swollen paralyzed legs Livelier, but eats nothing
4	7:00 P.M.	...	...	5.0	Stronger, but still refuses food; edema much diminished
5	1:00 P.M.	...	...	4.9	Same
6	5:30 P.M.	...	...	4.8	Eats meat with poor appetite; swelling slight in right hind leg, absent from left
7	6:00 P.M.	...	...	4.9	Gains appetite slowly
8	4:00 P.M.	...	...	5.4	Better; edema all gone
10	3:00 P.M.	...	...	5.1	Lively and active in spite of paralysis; permanent recovery

solutions, and Rosenthal finds benefit from intrastomachal administration of salt solution in burned mice (necessarily hindered by the nausea accompanying shock in species able to vomit).\* Nevertheless throughout this long time not one investigator has disputed the gross errors of fact, namely, the alleged rôle of loss of blood colloids in shock and the alleged ineffectacy or actual harmfulness of large crystalloid

replacement of plasma protein has been accepted as the most urgent necessity for overcoming hemoconcentration, and the harm of crystalloids has been ascribed to their increasing the loss of circulating protein. Yet, in the same institutions and by the same individuals this same explanation of hypoproteinemia is given for the state of the blood in conditions such as edematous kidney disease, which is opposite to the state in shock. As will be shown later, the large saline injections in these experi-

\* Also the recent paper of Prinzmetal and collaborators.

ments do carry considerable plasma protein out of the circulation; the result is that the acutely threatening shock is replaced by a condition comparable to the well known clinical states of hypoproteinemia. The essential effect of the saline treatment thus is to save life temporarily or permanently, by converting hemoconcentration into hypoproteinemia or hydremia.

#### EXPERIMENTS WITH MUSCLE TRAUMA

To meet a possible objection that ligation of limbs does not adequately reproduce traumatic shock, experiments were performed with other recognized forms of shock. To begin with the form which is undeniably traumatic, dogs were given 500 blows with a padded hammer on each thigh, with force which was designed to produce maximum contusion without injury to bones or extreme fragmentation of muscles. Typical shock symptoms led to death within a few hours.

Three unsuccessful treatments may be briefly summarized as follows.

Dog 355, weighing 10 kilograms, had the thighs partially traumatized by 300 blows at 2:30 P.M. At 5 P.M. shock was evident, but the combined edema and hemorrhage seemed to balance each other so as to maintain practically unchanged blood counts of 5.2 to 5.4 millions. Then 200 more blows were given to each thigh, and at 9:15 P.M. the condition was dangerous with a cell count of 8.1 million. At 10 P.M. it was critical with a count of 8.8 million. Treatment was given in the form of an injection of 1,100 cc. saline immediately after 10 P.M. and again at 11:30 P.M. These intentionally excessive over-fillings of the circulation were borne without acute danger and with the usual striking recovery. Life was prolonged until 3 P.M. the next day, with red cell counts between 7.0 and 4.5 million. The death was due to pulmonary edema, without free fluid in the serous cavities.

Dog 359, weighing 8.2 kilograms, received the full thigh trauma at 7 A.M., and at 5:20 P.M. was in the act of dying with a red cell count of 9.9 million. A quick injection of 750 cc. of saline was given into the previously prepared jugular vein. This injection was repeated at

6:45 P.M.; then injections of 500 cc. were given at 8, 9:15, 9:30, 10 and 11 P.M. (total 4,000 cc., or about half the body weight, in five and one-half hours). The red cell counts fell to a final minimum of 3.8 million. There was the usual improvement with the first injections, but with the later injections urination became scanty and dyspnea urgent, until death occurred at 11:25 P.M. The lungs were found very edematous, also the pancreas, and the peritoneum was full of clear fluid. The extreme increase of leg edema in all the dogs with trauma was the same as in those with ligation. This experiment showed that the other effects of a large excess of saline were also similar.

Dog 368, weighing 7 kilograms, received the usual trauma and was allowed to go on to the final apnea. The notable feature was that owing to a slight accidental delay, the heart action had become impereceptible by the time the needle entered the vein and resuscitation seemed hopeless. Nevertheless two injections, each of 100 cc. saline, were given together with artificial respiration and heart massage. Very slow and feeble breathing and heart beats returned and improved gradually during ten minutes. During one-half hour after that, 1 liter more saline was injected. The heart and breathing became practically normal, the conjunctival reflex was strong, and semiconscious movements began. After one and one-half hours of this improvement there was a sudden change for the worse, followed by death within fifteen minutes. Autopsy showed the cause to be a stomach full of water, regurgitation and aspiration into the lungs.

Dog 371 furnished an example of lasting recovery from advanced shock with the aid of moderate saline injections, as shown in Table III. The condition for at least twenty-four hours after the end of the injections was exceptionally good. The infections of the traumatized muscles which caused death on the eleventh day were large enough to have been fatal in a normal dog.

#### COMMENTS

The results with trauma are entirely similar to those with ligation of limbs, and the preceding comments are applicable.

The experiment with dog 371 (Table III) carries the study one step farther, by showing that a dog can recover from the extreme stage of shock with the aid of "moderate"

saline injections (one-sixth of the body weight). This and some other observations support the following conclusions: There

within moderate bounds. The existing evidence indicates that this amount of saline can be safely tolerated by shocked dogs and

TABLE III  
DOG 371

Day of Experiment	Hour	Saline Ce.	Urine Ce.	Red Cells, Millions	Incidental Notes
1	7:30 A.M.	...	...	5.8	Weight 12 lb. (5.4 kg.); nembutal 180 mg.
	8:00 A.M.	...	...	...	Trauma to thighs
	9:50 A.M.	...	...	6.2	Temp. 96°F.
	11:45 A.M.	...	...	...	Auscultatory blood pressure unobtainable
	12:40 P.M.	...	...	8.1	Unconscious; eyes sunken; extremely critical condition
	12:45 to 12:55 P.M.	400	50	...	Stronger; good conjunctival reflex
	1:00 P.M.	...	...	2.9	Systolic brachial pressure 105 mm. by auscultation
	3:40 P.M.	...	210	4.6	Blood pressure not obtainable
	4:00 to 4:10 P.M.	200	...	...	At end of injection opens eyes, whines and moves
	5:45 P.M.	...	105	3.4	Eyes full, not sunken; temp. 99°F.; sits up feebly; brachial systolic pressure 125 mm.; shivering spoils diastole
	6:00 to 6:05 P.M.	100	...	...	Lies curled up normally
	7:15 P.M.	...	35	3.6	Crawls but cannot walk; brachial pressure 142/114; urine specific gravity 1.018
	8:25 to 8:30 P.M.	100	...	...	Temp. 100°F.; drinks 250 cc. water
	8:50 P.M.	...	...	...	Brachial pressure 160/120; slight diarrhea
	10:00 P.M.	...	100	...	Livelier; licks himself; drinks 350 cc. water; urine specific gravity 1.020; returned to cage in good condition; very large soft swelling of hind legs and flanks; weight 13½ lb. (6.1 kg.); total saline in 11 hours 900 cc., water 600 cc., urine 580 cc.
2	7:30 A.M.	...	...	2.8	Weight 13 lb.; large edema persists; afternoon, eats with fair appetite
3	7:00 P.M.	...	...	2.6	Weak, but eats
4	1:00 P.M.	...	...	2.3	Pus evacuated from right hind leg
11	Died in consequence of large abscesses of both thighs; lungs and other viscera normal.				

is no sign of dilution or elimination of a toxin by massive saline injections. A flood of polyuria is useless, and merely signifies a harmful or risky excess of saline. Shock even in its extreme stage should be treated without panic and without trying for a spectacularly rapid cure. It may be regarded as a self-limited ailment, in the sense that if the patient is merely kept from dying for a limited number of hours he will recuperate. This result is most prudently accomplished by giving the smallest saline injections which will either prevent hemoconcentration or keep it

only clinical trials can determine the human capacity.

#### EXPERIMENTS WITH BURNS

Experiments with burns involve various complications, including the anesthesia necessary to prevent pain. It is feasible to give a moderate preliminary injection of morphine, then etherize to the point of absent reflexes during the burning. Afterward, there may be just enough repetition of fractional doses of morphine or nembutal to keep the animal lightly asleep.

Boiling water was used to burn the hind-quarters of a small dog, and shock was allowed to progress to the final apnea.

The experiment was to show that the possibility of reviving in the very act of dying holds good also for shock from burns.

TABLE IV  
DOG 381

Day of Experiment	Hour	Saline Cc.	Urine Cc.	Red Cells, Millions	Incidental Notes
1	4:15 P.M.	...	...	5.8	Weight 10½ lb. (4.8 kg.); morphine 15 mg. subcutaneously; nembutal 90 mg. intraper.
	4:50 to 5 P.M.	...	...	...	Under ether, burned hindquarters with gas flame
	5:40 P.M.	...	...	7.6	Nembutal 60 mg.
	6:00 P.M.	...	...	...	Skin pockets dissected in groins
	6:45 P.M.	...	...	8.2	
	7:45 P.M.	...	...	8.8	
	8:45 P.M.	...	...	8.8	Nembutal 30 mg.
	10 to 10:15 P.M.	...	...	...	Under brief ether, burned area enlarged by searing flanks
	11:00 P.M.	...	...	9.3	
	11:40 P.M.	...	...	9.5	Blood very dark and scanty; condition acutely dangerous
	11:45 P.M.	250	...	...	Conjunctival reflex returns; heart and breathing improved
2	12:10 A.M.	...	20	...	Specific gravity of urine 1012
	12:50 A.M.	...	...	8.6	Temp. 104°F.; very bloody diarrhea
	1:15 A.M.	...	...	...	Regained consciousness; nembutal 30 mg.
	1:30 A.M.	250			Tube shows stomach empty
	3:30 A.M.	...	85	7.1	
	3:50 A.M.	250			
	5:00 A.M.	...	140	6.5	Can stand feebly; drinks 300 cc. water; temp. 100°F.;
	5:30 A.M.	250	...	5.9	feces more watery and less bloody; weight 12 lb. (5.4 kg.); returned to cage in fair condition
	6:00 A.M.	...	190	...	Sits up in cage weakly; temp. 102°F.
	2:30 P.M.	...	...	5.0	
3	3:00 P.M.	250	...	...	Same condition; feces without blood
	8:00 P.M.	...	...	...	
	Found dead. Autopsy: Only intense inflammation on medial surfaces of thighs. On lateral surfaces and over abdomen and flanks the skin is dry and dead and muscles are cooked more or less deeply. Heart half filled; lungs congested, not edematous; liver and pancreas normal; spleen normal size but very dark; kidneys slightly gelatinous on cut surface; adrenals congested and somewhat swollen. Microscopic: Lung, marked engorgement; liver and pancreas normal; spleen; marked engorgement of pulp; many follicles have early central necrosis. Kidney; convoluted tubules contain small amount of albuminous material; other components normal. Adrenal; extreme engorgement of capillary bed; cells of all layers extremely foamy, but especially in glomerular zone, where they have glassy clear appearance.				

While the heart was still beating strongly, an intravenous injection of 300 cc. saline was given and produced the usual recovery. Half an hour later 200 cc. more was injected, and after another half-hour the dog died from regurgitation and aspiration of water from the stomach, due to too deep narcosis. The only value of this

Dog 381 (Table IV) was burned deeply with a gas flame over the hind legs, except that on the medial surfaces the attempt was made to produce only severe inflammation without necrosis. To increase the shock the abdomen and back were burned later, so that the total area of severe burning covered nearly half of the body. The collection of exudate from the groins will be described later. Saline injections

were begun when the animal was not actually dying but was obviously close to that point. The total infusion was 1,000 cc. in five and three-fourths hours, with an additional 250 cc. nine and one-half hours later, amounting to slightly over one-fourth of the body weight. The temporary reviving influence was as marked as in other forms of shock. Impending death was averted and life was preserved to some time between twenty and thirty-two hours from the beginning of treatment. The condition at the twentieth hour seemed so good that death overnight was unexpected, but the intoxication connected with a deep burn of nearly half of the body surface may suffice for an explanation. The lungs and other organs showed none of the edema characteristic of excessive saline injections, and whether the congestion should be attributed to shock or the other intoxication which is reputed to result from burns is undecided.

#### COMMENTS

The fluid and protein in a "wheal" can be resorbed through capillaries or lymphatics, but burns introduce the new factor of escape of fluid outside the body through oozing or blisters. This loss of plasma protein through inflamed surfaces may be classed with the long familiar rice-water stools of cholera. Presumably there is depletion of the blood in cholera and restitution of the lost protein would be beneficial. It is also probable that a few liters of plasma would maintain the normal blood volume and corpuscle percentage and yet would not be as life-saving as ten times the volume of salt solution. Even if more abundant stools carry off more protein they should not be suppressed by dehydration. Here the mere normality of the plasma-corpuscle ratio does not prove absence of dehydration; an increased concentration of plasma protein may glut the circulation with a fluid which escapes with difficulty, but the necessity for saving life is an abundance of salt solution which can escape easily from the vessels.

This reasoning regarding cholera may also be applicable to burns. The present experiments were limited to showing that

the most extreme stage of shock from burns can be reversed and at least the acute stage tide over by saline solution in a manner equalling or surpassing anything that has ever been demonstrated for plasma.

#### EXPERIMENTS WITH HEMORRHAGE

Any delayed prostration or death from hemorrhage may rightly be designated as hemorrhagic shock. This condition cannot be limited within arbitrary standards but is widely variable, experimentally and clinically, according to the amounts of blood loss, time and other factors. The response to treatment varies accordingly. Inasmuch as blood loss beyond a certain point is irreplaceable by salt solution, it was inevitable that some failures of saline treatment should be encountered in this impure form of shock, especially under such extreme conditions as formulated by Huizenga, Brofman and Wiggers. There is greater clinical importance in showing that animals which are plainly dying from repeated hemorrhages can under some conditions be benefited by massive saline infusions.

Dog 378 (Table v) was bled from the carotid by degrees from 1:45 to 8 P.M., to the extent of 485 cc. Wiggers emphasized the variable reaction of dogs to hemorrhage, but this bleeding amounted to about 7 per cent of the body weight as compared with the 5 per cent which most authors set as the requisite of slow hemorrhage to produce fatal shock. The state of unconsciousness and moderate dyspnea persisted for three hours and would evidently have proved fatal soon. The opposing tendencies to blood dilution and concentration were presumably responsible for keeping the corpuscle count practically unchanged around 5 million, but the flow from the ear vein became excessively scanty and dark. It seemed prudent to give an intravenous injection of 500 cc. of saline, which produced slight but not spectacular improvement. One hour later a dangerous maneuver was risked, by withdrawing 125 cc. of blood from an animal already deep in hemorrhagic shock. At the end of this bleeding the carotid flow was coming only in drops, and the gasping dyspnea gave warning of immediate

death. With the injection of 500 cc. of saline the animal soon regained consciousness and drank water copiously. Life continued for a

retically, it is incredible that loss of a large part of the corpuscle supply does not introduce a complication in the bodily reaction,

TABLE V  
DOG 378

Day of Experiment	Hour	Blood Withdrawn, Cc.	Saline, Cc.	Red Cells, Millions	Incidental Notes
1	1:00 P.M.	...	...	...	Weight $14\frac{3}{4}$ lb. (6.7 kg.); nembutal 240 mg. Brachial pressure $135/92$  Nembutal 120 mg. Unconscious, dyspneic Ear blood dark and scanty; pulse weak; blood pressure unobtainable Symptoms not much changed
	1:30 P.M.	...	...	5.2	
	1:45 P.M.	120			
	3:15 P.M.	140	...	5.0	
	7:20 P.M.	...	...	...	
	1:30 to 8:30 P.M.	225	...	...	
	11:00 P.M.	...	...	5.0	
	11:15 P.M.	...	500	...	
2	12:15 A.M.	125	...	...	Extreme acute dyspnea; dying Regains consciousness; drinks 200 cc. water Drinks 450 cc. water Ear blood still scanty and dark; brachial pressure 150, 0; weight $15\frac{3}{4}$ lb. (7.1 kg.); returned to cage; able to stand Stands and walks, but refuses food
	12:20 to 12:30 A.M.	...	500	...	
	3 to 5 A.M.	...	...	...	
	6:30 A.M.	...	...	2.2	
	6:00 P.M.	...	...	...	
8	9:00 A.M.	...	...	2.1	Has been eating with fair appetite; nasal discharge like distemper
9	Found dead. Autopsy:	Pneumonia right lung; large amount of clear fluid in peritoneum; viscera negative; microscopic examination only of adrenal, which was normal.			

week longer, and it is uncertain whether the termination should be attributed more to chronic anemia or to respiratory infection due to the lowered resistance.

Dog 377 was bled at intervals as shown in Table VI, to the extent of about 5 per cent of the body weight. Progressive weakness led to terminal apnea three and one-half hours after the final bleeding. The successive saline injections brought progressive degrees of recovery. Chronic anemia then kept the animal weak. Treatment with saline injection and blood transfusion on the eighth day was too late, and death occurred during the following night.

#### COMMENTS

Hemorrhage has great practical importance as a cause or accompaniment of shock, but for theoretical study it introduces serious confusion, as illustrated by existing disputes in the literature. Theo-

especially to a condition in which anoxia is preëminent. Practically, there is no remedy for hemorrhage except transfusion with blood or an equivalent colloid solution. A crystalloid solution or any other remedy for simple shock may still leave the hemorrhagic case hopeless. But only study of the purer forms of shock makes it possible to comprehend that salt solution may be effective in late hemorrhagic shock, possibly even where transfusion fails, and then transfusion may be needed as an accessory to correct the hemorrhagic factor.

Three incidental points are noteworthy:  
(1) Sustained elevation of blood pressure, which authors have failed to obtain in late hemorrhagic shock with transfusion or with inadequate saline injections, is sometimes obtainable with a sufficient volume of salt

solution, furnishing another illustration of the specific relation of sodium chloride to blood pressure. (2) In hemorrhage, both

circulating blood has an influence, and this is lacking in hemorrhage. (3) In the absence of local damage, there is absence of

TABLE VI  
DOG 377

Day of Experiment	Hour	Blood Withdrawn, Ce.	Saline, Ce.	Urine, Ce.	Red Cells, Millions	Incidental Notes
1	9:10 A.M.	...	...	...	6.1	Nembutal 240 mg.; weight 20½ lb. (9.3 kg.)
	9:30 A.M.	150				
	10:40 A.M.					
	11:00 A.M.	150				
	2:00 P.M.	...				
	2:45 P.M.	150	...	...	5.8	Nembutal 60 mg.
	4:00 P.M.		...	...		Pulse 240; resp. 24, deep and labored; brachial systolic pressure 174 mm.
	6:00 P.M.		...	...		Acute followed by quiet dyspnea
	6:10 P.M.		...	...		Brachial systolic pressure 84 mm.
	6:10 to 6:15 P.M.	500			3.9	Unconscious, dyspneic. Good conjunctival reflex; ear blood dark and scanty
	7:00 P.M.		...	...		Sudden terminal rigor; apnea
	7:05 to 7:15 P.M.	500	280		3.3	Sunken eyes fill out; spontaneous winking
	8:30 P.M.	...	300			Slight consciousness
	8:45 P.M.		...	...	5.3	First urine; specific gravity 1016
	10:15 P.M.					Running movements and crying; urine specific gravity 1013; systolic brachial pressure 158
	10:45 to 11 P.M.	500	320			Ear blood more abundant but still dark; stands drunkenly; drinks 300 cc. water
						Urine specific gravity 1012
2	12:30 A.M.			Lost		Crawls but cannot stand; drinks 500 cc. water
	3 to 5 A.M.					Walks feebly; drinks 1200 cc. water
	6:00 A.M.	...	...		2.4	Systolic brachial pressure 166. Returned to cage; wags tail feebly; wt. 21 lb. (9.5 kg.)
4	3 P.M.	...	...	...	3.1	Acts well except for great weakness; eats nothing
8	9:00 A.M.	200	...	...	1.9	Dyspneic; too weak to stand; temp. 100°F., has eaten nothing since experiment; 100 cc. normal dog blood injected with saline at 9 A.M. and 6 P.M.
	6:00 P.M.	100				
9	Found dead. Lungs and other viscera negative; no ascites. Microscopy only of adrenal, in which it is noted only that glomerular zone is narrow, fascicular zone wide, reticular zone normal in width but having foamy cells with scanty pigment.					

plasma and corpuscles are hopelessly lost. The exudate in a severely traumatized area coagulates and can be only slowly resolved, but serum is free with its proteins; and in a less injured area or around the periphery of severe injury the coagulable exudate does not clot, so that there can be practical benefit in the rather rapid recovery of these materials through the lymphatics. Theoretically as well as practically, the equilibrium between the exudate and the

increased capillary permeability with hemorrhage, as shown by the very slight gain of body weight with the large saline infusions. The longest and severest anoxia makes no such change in the capillaries, or else it is immediately cured by the treatment. The tendency to exudation in special areas, such as the lungs, may be classed among the phenomena of circulatory failure. The late ascites in dog 378 may be interpreted as an anasarca from prolonged

impoverishment of blood proteins even in the dog, and in man this tendency is greater.

In both hemorrhage and shock, all authors have agreed that salt solution is temporarily beneficial but it leaves the circulation very quickly. This being so, there must be room in the circulation for more salt solution, and the question arises why nobody has ever attempted to prolong the benefit by continuing the injection. Excretion through the urine is limited, and apparently everybody has had a dread of drowning a patient in edema, and recently an added fear of washing protein out of the circulation. These experiments show that the leakage of a crystalloid solution is not unlimited, but that a new equilibrium is finally reached between blood and tissue fluids which provides a sufficient volume of circulation to maintain life for a considerable time. A double possibility, that this blood volume is actually greater than normal and/or that the smallest blood vessels are abnormally relaxed, is suggested by the profuse flow of thin bright blood from a cut ear vein. Obviously the quantity of blood loss for which this compensation suffices is limited, for the reduction to absurdity would be in the supposition of preserving life without either plasma or corpuscles. In practice the plan may be harmful if it increases a bleeding that is still in progress. The experimental suggestion, however, is that with saline infusions there may be a zone of temporary safety between fatal hemorrhage on the one hand and pulmonary edema on the other.

In summary, two lessons may be drawn from these experiments: (1) In hemorrhage, just as in the forms of shock previously studied, there is an alteration of such a nature that large saline infusions are not quantitatively lost from the blood stream within twenty-four hours as they are in normal animals, but on the contrary they may provide a volume of dilute blood sufficient to maintain life for hours or days. Theoretical explanations based either on a toxin or a continuing absorption of a mass of edema, which could be suggested in

traumatic shock, are excluded in hemorrhage. (2) In practice, even if this new abnormal equilibrium between blood and tissues should in itself be ultimately fatal, it may sometimes preserve life through an emergency or shock period until it is possible to obtain the real cure for hemorrhage, namely, transfusion.

#### PATHOLOGICAL OBSERVATIONS\*

In only one instance was there a report of completely normal lung, liver, kidney, spleen, pancreas and adrenal. This was in a dog which had been subjected to severe shock by ligation of both hind legs for nine and one-fourth hours, and had been successfully treated by immediate refrigeration of the hind legs (with intermittent tourniquet applications) and moderate fluid administration by stomach and intravenously during thirty hours. The dog was killed thirty hours after termination of this treatment.

The other animals were those which died from excessive saline injections, or from aspiration or other accidents. The findings in general may be summarized as follows:

The lungs were reported normal in only three instances namely, dog 361† in which hemoconcentration was prevented from the outset, another dog in which death was long delayed but not prevented by local refrigeration, and one accidental death in the midst of the saline injection treatment. The others showed various degrees of congestion and edema, which were the usual cause of death.

The liver (which usually appeared large, sometimes wet and more or less congested in gross) was sometimes normal and sometimes described as having "the entire capillary bed extremely engorged."

The kidneys (which were grossly more or less wet) were reported as either normal or containing a little detritus in the tubules.

\* Cordial thanks are due to Dr. James R. Lisa of the City Hospital, New York, for microscopic examinations of the principal viscera of sixteen dogs that were treated for shock.

† Am. J. Surg.; 61: 79-92, 1943.

The spleen (which was never enlarged but frequently very dark) received the following descriptions in different animals: (1) normal, (2) engorged, (3) frequently a peculiar empty state of distended capillaries and sinuses and (4) with a little central necrosis in follicles.

The pancreas (which in gross might be normal or enveloped in an enormous clear edema of the areolar tissue) was always microscopically normal. The absence of any suggestion of the hydropic island cells characteristic of diabetes was interesting under these conditions of extreme edema.

The adrenals were examined carefully for any sign of abnormality in connection with the short or long periods of shock, burn, hemorrhage, etc. Grossly, there was sometimes a suspicion of shrinkage of the cortex. Microscopically, the medulla was always normal. The descriptions of the cortex included variations in the width of the three zones, in the clear or foamy appearance or the pigment content of the cells, but no consistent correlation with either the shock or the sodium chloride infusions was apparent.

Congestion of the intestinal mucosa is one of the most striking anatomic phenomenon in shock, occurring more markedly in the dog and other laboratory species than in man, and reaching a degree which is clearly recognizable by gross examination. This congestion in the duodenum and lower colon or rectum may, as described by Moon, be so intense that the mucous membrane looks like red velvet. The bloody exudation appears as fluid in the bowel and as the characteristic bloody diarrhea of shocked animals. This process may extend in variable degree to the stomach, jejunum and other parts of the alimentary canal. Gross examinations of this series and of many other animals have shown all degrees, ranging from the full characteristic congestion to absence of visible congestion. The time and thoroughness of the treatment seem to be the decisive factors. The anatomic alterations correspond to the changes in the diarrhea, which under saline

treatment increases in quantity but ceases to be bloody. There may seem to be a contrast between the clearing up of engorgement in the intestine and the failure to clear it up in the lungs, but in reality the process is probably similar. In the intestine a more scanty bloody exudate is replaced by a more copious watery one. In the lungs likewise the bloody pneumonia-like engorgement is more or less converted into simple edema.

The total anatomic findings may be summarized as a mixture of residues from incompletely controlled shock and consequences of excessive fluid injections. In proportion as shock is prevented or controlled by the treatment, the pathologic changes are also abolished.

#### CHEMICAL OBSERVATIONS\*

Dog 267† at autopsy had non-protein nitrogen 33 mg. per cent, and the protein content was 3.6 per cent in the plasma and 1.4 per cent in the edema fluid.

Dog 376 (Table VII) showed the following at autopsy:

	Non-protein Nitrogen mg., Per Cent	Protein, Per Cent	Specific Gravity	Total Solids, Per Cent	Ash, Per Cent
Plasma.....	43	3.7	1.022	3.27	0.50
Exudate.....	..	5.0	1.021	5.42	0.49

Two dogs died with severe anemia eight days after large saline injections for hemorrhage and shock (Tables V and VI). In samples taken on the last day of life, the plasma of dog 377 contained 60 mg. per cent non-protein nitrogen and 7.0 per cent protein, and that of dog 378 contained 23 mg. per cent non-protein nitrogen

\* Through the courtesy of Dr. Lisa, protein analyses of oxalated samples of plasma and exudates were performed by Mr. Max Friedman in the chemical laboratory of the City Hospital. Thanks are also due to Dr. Israel S. Kleiner of the New York Medical College for the determinations of specific gravity, total solids and ash content of heparinized samples.

† Am. J. Surg., 61: 92, 1943.

and 5.1 per cent protein. There appears to have been more rapid and successful restoration of plasma than of corpuscles, and the deleterious

The skin inflamed by burning was dissected up to form subcutaneous inguinal pockets in dog 381 (Table IV), and the exudate was col-

TABLE VII  
DOG 376

Day of Experiment	Hour	Plasma, Cc.	Urine, Cc.	Red Cells, Millions	Incidental Notes
1	8:30 A.M.	...	...	5.4	Weight 12 lb. (5.45 kg.); nembutal 240 mg.
	8:45 A.M.	...	...	...	Hind legs ligated
	10:00 A.M.	...	...	...	Nembutal 120 mg.
	3:45 P.M.	...	...	6.0	Tourniquets removed (7 hr.)
	4:45 P.M.	...	...	8.5	Brachial blood pressure unobtainable
	5:15 P.M.	...	...	9.1	Very weak, apathetic; ear blood dark and scanty
	5:20 to 5:30 P.M.	100			
	5:35 P.M.	...	...	8.9	
	6:00 P.M.	100			
	6:45 P.M.	...	...	6.7	
	7:15 P.M.	50	...	...	Symptoms unchanged, except better breathing
	9:00 P.M.	...	50	...	Unable to stand; brachial pressure unobtainable
	9:30 P.M.	...	...	7.4	Vomits a little mucus
	9:45 P.M.	150*	...	...	Gradual general improvement; * desiribinated blood instead of plasma
2	10:30 P.M.	...	...	...	Can barely stand; drinks 250 cc. water
	11:45 P.M.	...	...	7.8	Ear blood dark, scanty
3	1:00 A.M.	50	...	8.0	Weaker again; violent heart action
	1:45 A.M.	50	...	...	Improved; sits up feebly
	2:00 A.M.	...	...	7.0	Drinks 200 cc. water
	3:00 A.M.	50	...	7.7	Large hard swelling of hind legs
	5 to 5:15 A.M.	125	Lost	6.1	Gradually able to stand and walk; brachial pressure unobtainable; weight 13½ lb. (6.1 kg.); returned to cage
	1:30 P.M.	...	Lost	6.4	Spastic; inco-ordination prevents standing
	6:00 P.M.	...	...	6.8	Same; cannot drink, given 250 cc. water by tube
3	7:00 P.M.	...	...	...	Increased spasticity; water 250 cc. by tube
	1:00 P.M.	...	...	5.8	Lies flat, dimly conscious, evidently dying; temp. 102°F., large edema thighs to ribs
	1:20 to 1:30 P.M.	...	...	...	Saline 500 cc. injected in jugular. Nearly empty vein fills; heart stronger
	2:00 P.M.	...	80		Dyspnæa increasing
	3:00 P.M.	...	120	4.5	Saline 500 cc. injected in jugular
	3:15 to 3:30 P.M.	...	...	...	Died; count made on heart blood.
	4:10 P.M.	...	...	5.4	

Autopsy: Lungs edematous and intensely congested. Liver dark; dry rather than wet; kidneys wet; spleen exceptionally small.

Microscopic: Liver and adrenal normal; spleen "looks empty of blood; the blood sinuses are dilated but contain few cells."

effect of a deficit of corpuscles seems to have been greater than most recent writers have assumed. This result, which is encouraging as regards rebuilding of plasma proteins after saline infusions, might be surpassed in traumatic shock in which there is the opportunity for resorption from the "wheal."

lected with a spoon. Between collections the skin edges were held together by towel clips. A blood sample at 8 P.M. contained 41 mg. per cent non-protein nitrogen and 6.1 per cent plasma protein. The exudate collected from 6 P.M. to the beginning of the saline injection at 11:45 P.M. was very thick and bloody; the total

for the two groins was 8 cc., and the protein content was 9.9 per cent, evidently explained partly by the admixture of cells. Following the saline injections the exudate became visibly thinner, more abundant and less bloody. A blood sample at 4:30 A.M. contained 32 mg. per cent non-protein nitrogen and 4.0 per cent plasma protein. The exudate collected from 11:45 P.M. to 5 A.M. totalled 11 cc., and contained 8.0 per cent protein. While this flushing out of plasma protein was trivial, there could doubtless be a much greater increase from saline infusions in cases with greater exudates from larger surfaces.

Two experiments were performed for this special purpose in the shock produced by ligation of legs.

Dog 380, weighing 6.8 kilograms, had tourniquets on both hind legs for five and one-half hours. The subcutaneous pockets were formed as usual by a short incision and then lifting up the entire inguinal skin by blunt dissection without hemorrhage. Collection of the exudate was begun at 2:15 P.M., which was two and one-fourth hours after removal of the tourniquets.

Saline injections were begun with 500 cc. at 6:20 P.M., when the condition was rather critical. This injection was repeated at 7:30 P.M. and at 1:00 A.M. The dog also drank 500 cc. of water at midnight. The swelling of the hind legs was greatly increased by the injections, but the increase of free fluid in the groin was not great. The percentage of protein in this fluid was not greatly decreased with the injections as compared with the last preceding period. Both increased blood volume and the passage of protein into the swollen hindleg tissues can explain the marked fall in the plasma protein percentage.

#### DOG 380

Blood				
Time	Red Cells Millions	Non-protein Nitrogen Mg., Per Cent	Plasma Protein, Per Cent	Plasma Specific Gravity
4:00 P.M. ....	8.2			
6:15 P.M. ....	9.3	48	5.0	
7:15 P.M. ....	7.4			
8:00 P.M. ....	6.6	40	2.6	1018
12:45 A.M. ....	5.6			
1:15 A.M. ....	...	31	2.0	
2:00 A.M. ....	4.8	37	3.1	1013

#### Allen—Shock

Exudate				
Time	Character	Volume Cc.	Protein Per Cent	Red Cells Millions
2:15 to 4 P.M. ....	Bloody, thick	5	8.2	2.1
4 to 6:15 P.M. ....	Same	3	4.2	3.2
6:15 to 8 P.M. ....	Thinner, hemolyzed	6	3.7	
8 P.M. to 1:15 A.M. ....	Thinner, less red	9		
1:15 to 2 A.M. ....	Thinner	5	3.9	Rare

To test whether the thinning of the exudate was merely a spontaneous occurrence with time, as the intensity of the inflammation subsided, the experiment was repeated with a modification.

#### DOG 382

Blood			
Time	Red Cells Millions	Non-protein Nitrogen Mg., Per Cent	Plasma Protein, Mg., Per Cent
6:30 P.M. ....	6.0		
7:15 P.M. ....	...	29	5.0
8:15 P.M. ....	5.9		
9:30 P.M. ....	6.6		
11:30 P.M. ....	6.2		
12:45 A.M. ....	7.1		
2:30 A.M. ....	5.6		
4:15 A.M. ....	4.3	29	3.2

#### Exudate

Time	Character	Volume Cc.	Protein, Per Cent
5:30 to 8:30 P.M. ....	Thin, slightly turbid	17	3.8
8:30 to 11:30 P.M. ....	Same	12	4.5
11:30 P.M. to 4:45 A.M. ....	Thinner	7	2.9

Dog 382, weighing 4.8 kilograms, had circulatory stasis of the hind legs for five and one-fourth hours. Saline (125 cc.) was injected intravenously soon after the tourniquets were applied, and 250 cc. shortly before they were removed. With the first swelling of the legs not

a drop of fluid appeared in the inguinal pockets, and the collection of exudate could begin only one hour after the tourniquet removal (5:30 P.M.). From the beginning the exudate was far more clear and copious than in the preceding experiment without saline injections. The protein percentage nevertheless was not far below that of the blood plasma, and the two fell in parallel in consequence of additional saline injections of 125 cc. at 5:25 P.M., 250 cc. at 11:35 P.M., 250 cc. at 1:20 A.M., and 125 cc. at 2:35 A.M.

The therapeutic result was unexpectedly poor. There had been some expectation that the preliminary saline injections, beginning during the ligation period, would aid in preventing shock by providing an advance supply of fluid. The dog was weak and dyspneic notwithstanding the prevention of hemoconcentration and died at 5:30 A.M. The autopsy showed ascites and unusually intense pulmonary edema and a congestion amounting to hepatization in some lobes. It was proved with the tube that the stomach was empty from beginning to end of the treatment, but an aspiration during the ligation period is not excluded though improbable. Apart from such an accident, there is surprising similarity with a case reported by Keating, Rynearson and Power, in which a woman had exceptional difficulties after strenuous saline preoperative preparation. As there is poor absorption of fluid from the tissues in shock, it is theoretically possible that preliminary saline injections may overload the vital organs with fluid which only embarrasses them when shock begins. Further experimentation might decide.

Various observations have shown that the large clear exudates following the saline injections do not coagulate in the living tissues, but do coagulate after death or after collection unless oxalated or heparinized. Therefore, though the passage of more protein out of the circulation is confirmed, the exudate remains as a fluid mass in osmotic equilibrium with the blood and as a reservoir of recoverable protein by absorption through the lymphatics.

#### PLASMA INJECTIONS

For completeness, plasma and other fluids should be compared with the plain physiological saline, and the question of the effect of plasma in the reputedly irreversible stage of shock should be reopened. Quantities of plasma or any other colloid solution, comparable to the saline volume in these experiments, cannot possibly be tolerated by the organism. Therefore, an experiment was performed with heparinized dog plasma administered in such quantities as would conform with the physiological standard which was found optimal in the saline experiments, namely, to prevent the rise in erythrocyte counts or hold it within moderate bounds.

Dog 376 (Table VII) developed rapidly progressive shock after a seven-hour ligation of both hind legs. Within one and one-half hours the condition was serious as shown by the blood count and symptoms, but it was not planned to await the agonal stage. Plasma was therefore injected in such amounts as would hold down the corpuscle counts to a little above normal. (For comparison, it may be recalled that untreated animals never die from leg ligations unless the shock is severe enough to raise the corpuscle counts by far more than 2 millions.) The total of plasma injected was 675 cc. during twelve hours.

The dog, which could scarcely have lived two hours longer, had a survival of over twenty hours which could be credited to the plasma. Various effects were different from those found with the larger volumes of saline. Plasma gave no such quick and dramatic recovery. The veins were not so well filled. The flow from the ear veins was never profuse. The blood remained abnormally dark, signifying continuance of anoxia in a diminished degree, and the venous blood never acquired an arterial color as with saline. Drinking and absorption of water (which is impossible in severe shock) became possible, and the thirst was not much different than with saline. The later state, when spasticity was more prominent than weakness, was different from anything seen with saline. There is a possibility that this condition and also the fatal outcome may have been due to something connected with the makeshift preparation of the plasma.

About twenty hours after the first plasma injection the dog was obviously near the point of death. Judging from the dyspnea, the pulmonary engorgement was already present. Therefore, two injections, each of 500 cc. saline, were given in order to learn whether this treatment could still save. Life was prolonged nearly three hours, probably as a mere result of increased blood volume. The course of symptoms together with the autopsy made it seem probable that the pulmonary congestion of shock was never cleared up, but on the contrary the plasma injections furnished time and material for it to reach a more severe grade.

The edema of the hind parts, though not as extreme as with the larger saline injections, appeared fully as great as with an equal volume of saline. The comparative analyses already given above showed 5 per cent protein in the exudate as compared with 3.7 per cent in the plasma, a difference which is doubtless explained by the saline injections shortly before death.

#### COMMENTS

An assertion of the superiority of salt solution over plasma is based primarily upon the published reports of other authors as controls, i.e., the observed benefits from saline injections are greater than those described by other authors with plasma. Although many of the failures in the literature seem to be explainable by narcotic poisoning or other technical faults, nevertheless the few experiments with plasma which were possible under the conditions surrounding this research furnish partial corroboration of these reports by others in the following respects: (1) Animals in the act of dying from shock can be restored by transfusion of blood or plasma to a greater degree and for a longer time than these writers have stated. Extreme tests (not detailed here) with intentional delay after breathing had ceased and until the heart had almost stopped, showed distinctly prompter and more decisive resuscitation with physiological saline than with plasma. (2) The saline solution accomplishes a better elevation of blood pressure, a freer restoration of diuresis, and (as far as can be judged by the color of the blood) greater

relief of anoxia than plasma. (3) The dilution of the blood with large saline injections is obviously prevented by using blood or plasma, but not beneficially, because the survival with saline has been longer. (4) Exudation into the injured area is slower and smaller with plasma than with saline injections. This hindrance to the passage of fluid to the tissues which need it may be one harmful effect of the colloids. Blood counts are made undependable as an index of hemoconcentration or dehydration. There are also some indications that the blood volume and circulation time are maintained by saline as well as or better than by plasma. (5) With either plasma or saline injections, death comes typically from the lungs, on account of either a specific toxin or a cumulative circulatory failure. It is not true that blood or plasma has the slightest advantage over saline in preventing this pulmonary death. On the contrary, the greater embarrassment caused by the thick colloid exudate as compared with the thinner edema fluid seems to furnish the principal reason why the saline-injected animals live longer.

In contradiction to the universally accepted teaching, it must be concluded that hypoproteinemia and colloids in general have nothing whatsoever to do with shock. The shocked animal or patient never dies from hypoproteinemia. Very marked degrees of hypoproteinemia are known clinically to be tolerated for very long periods with no symptoms resembling shock. The prevailing ideas have given origin to a current crop of clinical reports of poor resistance to surgical shock in patients with hypoproteinemia, and improvement of resistance by building up the blood proteins. But it is easy to prove (as I published in 1939) that animals which are weak or unwell from any cause whatever have reduced resistance to shock, even if they have fully normal blood composition. Hypoproteinemia, either as a cause or as an indication of a poor constitutional state, obviously ranks among the conditions of impaired resistance, but this fact does not imply any

specific relationship between hypoproteinemia and shock. The prevailing errors are a direct continuation of the misconceptions dating from the first World War.

#### WATER, GLUCOSE, VARIOUS ANIONS

The general trend of this work may appear to be to make shock almost synonymous with dehydration. Therefore, a trial was made by injecting 5 per cent glucose solution intravenously in a dog in the very late stage of shock following leg ligation. Slight dyspnea and then death occurred before an injection of 100 cc. could be finished, and an immediate change to hypertonic sodium chloride solution was ineffectual. In another dog, likewise in extreme shock, the solution of 5 per cent glucose in water was tried more slowly; danger signs developed and the animal was saved by a quick change to physiological saline. The only way of giving water by vein is in some such form as the glucose solution. The glucose is not to be considered toxic. It can doubtless be added to salt solution and also given without salt whenever there is a specific need for water and nourishment. But animals nearly at the point of death from shock are in an extremely sensitive condition, and their response proves that the specific need in shock is not for water or glucose but for sodium chloride solution.

Likewise, plasma containing any considerable quantity of sodium citrate proved fatal in the last stages of shock, and a change to simple saline solution could not revive the animal. The precipitation of calcium, which Moon mentions, may not be the whole explanation; at least, shocked animals have died when normal animals took the same quantity of the same plasma without apparent harm. I have suspected citrate (and likewise lactate) as a source of sodium bicarbonate, for reasons stated below. Some failures of plasma treatment may conceivably be due to the custom, especially among clinicians, of using citrated mixtures.

The reviewers refer to sodium bicarbon-

ate injections for the supposed acidosis of shock, and the early encouragement followed by abandonment. It may have minor value in small amounts as a source of sodium. The belief in a reduction in the percentage of bicarbonate in the plasma as an index of acidosis is an example of an error implanted in the literature without any proof and giving rise to widespread and long continued misconceptions. I have referred elsewhere (Allen, d) to experiments which were performed long ago but could not be published, in which dogs were bled just enough to cause dyspnea and the reduction of plasma bicarbonate thus produced (Mason and Hellman) was compensated by a sodium bicarbonate injection. The repetition of this process resulted finally in death from alkalosis with normal plasma bicarbonate content. With the migration of sodium in shock, there is no evidence that a fall of bicarbonate is on any different basis than the fall of sodium chloride in the plasma. Because of the impression from the above mentioned experiments that any considerable quantity of sodium bicarbonate would be fatal in severe shock, no such injections were tried. Also, although there are valid studies on the rôle of the sodium ion, and I recognized its special relation to hypertension as long ago as 1925, (Allen, a) it seems scarcely proper to refer to the chlorine ion as indifferent if no other anion can be successfully substituted for it. The results in shock are, therefore, attributed distinctly to the chloride of sodium until some other sodium compound can be proved similarly effective.

#### ADRENAL CORTEX—POTASSIUM

Scudder's book may be cited as a sufficient example of the literature which stresses these factors and advocates therapy with adrenal cortical extract. Superficial resemblances between adrenal cortical failure and shock are found in: (1) the clinical symptoms, (2) the occasional increased concentration of potassium and reduced concentration of sodium in the blood, and

(3) the benefit of sodium chloride administration in both conditions.

It is proper to criticize wasteful expensive data, which serve only to burden other workers with the task of disproving irrational theories. The status of the theory of adrenal cortical deficiency in shock may be summarized as follows:

1. As Moon has pointed out, Rogoff and Stewart in 1926 and 1928 showed that dogs lived an average of seven days after complete adrenalectomy. It therefore is scarcely reasonable that shock, which is capable of killing within less than twenty-four hours, can be explained by adrenal cortical failure.

2. The possibility that adrenal cortical deficiency may be a contributory factor, or that resistance may be increased by an added supply of the cortical hormone, has been tested by a number of authors using a variety of preparations. The most recent publications (Keating, Ryneanson and Power, Koster and Kasman, Bourque, Haternis and Glassco, Huizenga, Brofman and Wiggers, Prinzmetal) prove with apparent conclusiveness that these extracts are valueless in shock treatment. Furthermore, a combined treatment with extract and salt is known to help adrenalectomized animals. My experiments showed that saline administration markedly relieves shock, but in the severest cases the benefit is temporary and death is merely delayed. Something else is clearly needed to reinforce the benefit of the saline injections or counteract their danger, and it was natural to inquire whether any adrenal preparation might serve this purpose. According to my experience published in 1939, eschatin was useless or harmful in shocked rats. Recently two dogs in shock following leg ligations were treated with adrenal cortical extract. When this failed to retard the progress of the condition as judged by red cell counts and clinical symptoms, saline infusions were given along with additional extract. In comparison with the large number of available controls, it seemed obvious that small doses of the extract were useless and larger

doses shortened survival. For further information, one shocked dog was treated with continuous large saline infusions, to which adrenalin was added in concentration of 1/500,000. If vasodilatation was present, it was not beneficially affected; pulmonary edema was not prevented and survival was shortened. These few experiments serve to strengthen my former conclusion that all adrenal preparations are useless or harmful in the treatment of shock.

3. The superficial symptoms and the benefit of salt administration are misleading resemblances between conditions which are physiological opposites. After adrenalectomy, electrolytes flow off in the urine in such excess that the blood and then the tissues are depleted. In shock, there is an abnormal passage of fluid and electrolytes from the blood into the damaged tissues, and the discharge through the urine is diminished or stopped. Salt administration in adrenal deficiency compensates for the excessive urinary loss of salt. Salt solution administered in shock is primarily taken up by the injured tissues, and the renal excretion is not sufficient to prevent hemodilution. In other words, the increased passage of electrolytes through vessel walls is in opposite directions in shock and in adrenal deficiency. The hemoconcentration of shock is easily obviated by saline injections, but the hydremic plethora and edema of lungs and tissues should be relieved by something which assists in elimination of the surplus water and salt, not by anything which conduces to retention. The numerous symptomatic resemblances listed by Swingle and others between adrenalectomy and shock may be explained by the factor which they have in common, namely, loss of fluid and electrolytes from the blood in connection with circulatory failure and capillary atony. But it is astonishing that nobody has recognized the physiological oppositeness of the two conditions, inasmuch as the fluid-electrolyte migration is in opposite directions. Therefore, adrenal failure should not be designated as shock,

and to treat shock as if it were adrenal deficiency is irrational.

As regards the sodium-potassium ratio, it must be recognized that the fall in sodium and rise in potassium are inconstant and usually slight, also that Swingle and collaborators were evidently correct in their original view that the increased percentages of both potassium and calcium are merely incidental to hemoconcentration. The fact mentioned by Sollman, that the depressant action of potassium depends not on the absolute dose but on the concentration and the ratio to other ions, evidently explains the widely different lethal doses found by Scudder and earlier writers, according to speed of injection and other variables. Without citing the publications which discredit potassium intoxication as a factor in shock, an account will be given of a rudimentary type of tests in shocked animals which might have saved the setting up of the potassium theory in the first place.

First, Ringer solution (with the potassium chloride content ranging from 100 to 240 mg. per liter) gives results in shock indistinguishable from those of plain saline. Evidently the considerable quantities of potassium introduced with injections of one-fourth to one-half of the body weight, and likewise the calcium content, are immaterial for good or evil.

A test of the toxicity of potassium alone in shock was performed as follows: Both hind legs of a dog were ligated for six and one-fourth hours. In the ensuing forty-five minutes the red cell count rose to 7.6 millions and the dog was apathetic but conscious. An intravenous injection of 20 cc. of 1 per cent potassium chloride solution was then given slowly during five minutes. After another forty-five minutes the injection was repeated. Each time there was temporary dyspnea followed by some inhibition of respiration and later recovery. After the same interval, a third injection was given more rapidly. Dyspnea was followed by danger signs. Before the heart and respiration stopped, 400 cc. of physio-

logical sodium chloride solution was rapidly injected into the vein, without any effect in preventing immediate death. At autopsy the heart was distended with blood, the lungs were congested but the other viscera were normal. In particular, the entire intestine was free from the characteristic congestion of shock. Besides this, the failure of sodium chloride injection in the terminal stage is a cardinal distinction between potassium poisoning and shock.

As potassium always occurs in the extracellular body fluids in association with a much higher concentration of sodium, the next injections were performed with sodium-potassium mixtures.

Dog 407, weighing 6 kilograms, had tourniquets on both hind legs from midnight to 6:15 A.M. (six and one-fourth hours). One hour later, weakness and apathy were well marked. The solution for intravenous injection contained 8 Gm. sodium chloride and 1 Gm. potassium chloride per liter. Fairly rapid injections of 100 cc. each were given at 7:15, 7:45, 8:30 and 10:20 A.M., and 12:15, 12:45, 1:00 and 7:40 P.M. (total 800 cc. = 800 mg. potassium chloride). The shock symptoms were thus progressively lessened. The erythrocyte counts were kept between 5.4 and 5.9 million until noon, then fell to a minimum of 3.6 million at 5 P.M. and rose to 4.5 million at 7:30 P.M. Bleeding from the ear veins became almost as profuse as with pure sodium chloride solution, but instead of being bright red the color remained very dark. Weakness and depression were more persistent. Water drinking amounted to 210 cc. Diuresis was less than with plain saline, the total urine for the period being 65 cc. Except for some persistent apathy, the condition at 8:30 P.M. seemed to promise safety for the night. But next morning the dog was found dead, with edema and congestion of the lungs, heart nearly empty, other viscera normal, and in particular no sign of intestinal congestion or hemorrhage. There was no free fluid in the serous cavities, and the edema of the hind legs seemed about the same as with ordinary saline injections.

Two carotid blood samples taken during life furnished somewhat hemolytic serum.\* A sam-

\* Acknowledgment is due to Dr. Paul Riedel, of the chemical laboratory of Bellevue Hospital, for potassium analyses.

ple at 10:35 A.M., about fifteen minutes after the third intravenous injection, contained 31.5 mg. per cent of potassium. The sample at 7:55 P.M., about fifteen minutes after the final injection, contained 23.1 mg. per cent of potassium. Accordingly, there seemed to be no progressive increase of potassium concentration. In comparison with untreated animals, survival was greatly prolonged by the potassium-containing injections. Death appeared to be due entirely to pulmonary edema.

Dog 405, weighing 7.3 kilograms, had asphyxia of both hind legs from 9:15 A.M. to 2:30 P.M. (five and one-fourth hours). By 5 P.M. the erythrocyte count had risen to 8 million, and the apathy was such that the jugular and carotid could be exposed without apparent notice by the dog. The solution for intravenous injection contained 5 Gm. sodium chloride and 3 Gm. potassium chloride per liter. The injections were 50 cc. at 5:20 P.M., 100 cc. at 5:35 P.M., and 100 cc. at 6 P.M. (total 250 cc. = 750 mg. potassium chloride). There was some depression of heart and respiration with each injection, but subsequently the shock symptoms seemed somewhat diminished. The blood remained very dark colored. The blood pressure never became elevated enough for auscultatory determination. There was moderate bloody diarrhea but no urine. The eyeballs became strikingly hard and protuberant. Before an erythrocyte count could be made, the dog at 6:50 P.M. suddenly stopped breathing, while the heart continued to beat. Physiological saline had to be hastily prepared in the emergency and by that time heart action was imperceptible. Nevertheless 900 cc. of the physiological saline was injected, while artificial respiration and chest massage were performed. Heart and respiratory functions returned very slowly and gradually. By 7:10 P.M. there was a strong conjunctival reflex, otherwise there was total unconsciousness. Intravenous injections, each of 200 cc. physiological saline, were given at 8 P.M. and 9 P.M. Erythrocyte counts were 5 million at 7:55 P.M. and 4.1 million at 8:55 P.M. Diarrhea persisted and increased after 7 P.M., but it gradually became free from all visible blood. Spasticity, opisthotonus and hard bulging eyeballs became increasingly prominent, and death occurred in a spasm of opisthotonus at 9:45 P.M. The heart continued feebly after breathing stopped, but an additional injection of 500 cc. physiological saline had no effect.

Autopsy findings were as follows: Heart distended with blood; lungs moderately edematous; abdominal viscera normal, except for moderate intestinal congestion; no fluid in serous cavities and very large edema of the hind legs. On opening the skull the meninges were found tensely distended by the swollen brain. There was no congestion, and no cerebrospinal fluid was obtainable from the ventricles or surfaces. The swelling seemed to be strictly of the brain tissue itself.

Potassium analyses were made by Dr. Riedel. The potassium content of non-hemolytic serum was 37 mg. per cent at 5:10 P.M., 41.3 mg. per cent at 7:40 P.M., and 40 mg. per cent at autopsy. The clear exudate in the hind legs at autopsy contained 47.4 mg. per cent of potassium. In other words, the potassium concentration in shock prior to any injections was elevated practically in proportion to the hemocencentration shown by the erythrocyte count. The maximum potassium values were missed because of the spoiling of plans by the threatened death of the dog at 6:50 P.M., but they must have been notably high as indicated by the figure of 41.3 mg. per cent after dilution with 900 cc. of physiological saline, and at autopsy the potassium concentration in serum and exudate remained in this same range of approximately twice normal.

A complication was introduced by the fact that small repeated methylene blue injections had been given intravenously, beginning before the leg ligation for determining circulation time by the Jablons method. From 8 A.M. to 6:30 P.M. these injections, of 1 to 3 cc. each, totalled 22 cc. of 1 per cent methylene blue solution. Except for the apparently negligible chance that this quantity of methylene blue might have some peculiar effect in a shocked animal, the above described symptoms and autopsy findings must be attributed to the potassium mixture. Although no dye had been injected in the two hours before death various organs remained loaded with the colorless reduced form. On exposure to air postmortem, the blood, brain, intestine, kidney and spleen became deep blue. The liver remained normal in color but the bile was turned deep indigo. All muscles retained normal color. This result conforms to previous observations by Jablons. The only new detail is that both muscles and exudate in the hind legs remained free from blue color. In other words, the abnormal permeability of the blood vessels

was not demonstrated and also no abnormality of cell permeability or metabolism in the previously asphyxiated muscles was demonstrable with this dye.

The following facts may now be assembled concerning the potassium intoxication theory of shock: (1) Death due to shock always occurs by apnea, and the textbook statement that potassium kills by cardiac depression should alone have sufficed for a distinction. (2) Both the symptoms and the pathology of shock (notably the intestinal engorgement which is so distinctive in dogs) are different from potassium poisoning. (3) Animals in advanced shock are extremely sensitive to every additional shock-producing agency and also to such small disturbances as the glucose and citrate injections mentioned, but the tolerance for potassium compares favorably with that of normal animals in the literature and shock may be partially relieved by solutions having higher potassium concentration than ever reported in shock blood. (4) Physiological sodium chloride solution revives animals which are dying from shock and to a certain extent also when the collapse is due to mixed shock and potassium poisoning; but it has no effect whatever on an animal dying from potassium poisoning. For these reasons, speculations concerning potassium may be dismissed from the theory of shock.

The original purpose was not concerned with such fancies but only with a simple inquiry whether potassium might make a beneficial addition to saline injections for shock by reason of its reputed diuretic and anti-edema properties. On the contrary, the experiments showed: (1) Although shock can be relieved to some extent by saline injections containing potassium in concentrations exceeding the highest values ever reported in so-called hyperpotassemia, nevertheless every phase of the benefit produced by sodium is diminished by the presence of potassium. (2) The toxic depressant action of potassium depends more upon concentration than upon total dosage, and a relatively high dosage can be

tolerated in dilute form in shock, even though the diuresis ordinarily resulting from the sodium salt is inhibited by potassium. (3) The edematous effect of potassium is much greater than that of sodium. For example, dog 407 died from edema of the lungs after only 800 cc. of a potassium-containing injection, although this quantity of plain physiological saline is safely tolerated. In dog 405 the swelling of the eyeballs, and the clinical and postmortem evidences of swelling of the central nervous tissues, are different from anything obtainable with any quantity of sodium chloride solution, and (granting that the methylene blue was not a factor) they seem to represent a surprising specific effect of potassium.

These injections in higher dosage and in sufficient dilution to avoid most of the crude depressant action, may open up a new phase of the pharmacology and toxicology of potassium. Similar trials of mixtures of other cations, with or without potassium, may also give interesting results. It appears inconceivable, however, that the pulmonary congestion associated with the specific circulatory failure of shock can be overcome by any mere alteration of the injected fluid in respect to either crystalloids or colloids.

#### THEORY AND APPLICATION

As the literature of shock treatment has been dominated so long and so completely by the colloid chimera, it has been necessary to devote most of the preceding discussions to an attack on this myth. There has been no opportunity to investigate the probability that the results obtained are not due to the mere relative capillary permeability for colloids and crystalloids but to the special physiological rôle of sodium chloride. Moon quotes a conclusion of Leo Loeb that the sodium ion is the chief factor determining the movement of water in the body under both normal and pathological conditions. This should be placed over against the recent exaggerated emphasis on the very minor osmotic attraction of the colloids. Scudder also stated that

"sodium solution dilutes the inspissated blood in shock, increases the velocity of circulation, decreases the generalized vasoconstriction, and increases the elimination of potassium through the kidneys." This seems to be a sweeping recommendation for any shock treatment, especially if the last clause be changed to read, "and relieves anoxia." Nevertheless, every writer without exception has insisted upon plasma and its colloids as the one specific shock treatment. Scudder's case reports also show that in spite of the relaxation of contracted capillaries, the salt solution raised the low blood pressure of shock, sometimes to undesirably high levels in renal-vascular patients. After the failure of epinephrine and every conceivable artificial agent, the sustained elevation of the shock blood pressure merely by sodium chloride is so prompt and dramatic that it can scarcely be missed even by the professors who were unanimously unable to perceive the relation between salt and hypertension (Allen, a, e; also Allen and Cope). Shock is a metabolic problem, and the observations on both refrigeration and sodium chloride can be seen as an integral part of my long metabolic studies, which happen to have a surgical application.

This entire work, including refrigeration, was unnecessarily delayed for many years by denial of financing and facilities, so that the opportunity for application to the vast shock problems of the present war was lost. The present research would have been prevented except for the aid of two grants, each of five hundred dollars, from the Committee on Medical Research of the American Medical Association.

#### SUMMARY AND CONCLUSIONS

1. Experiments were performed on dogs with the fairly pure form of shock produced by asphyxia of legs, and comparative experiments with the more complicated conditions of muscle trauma, burns and hemorrhage. Some types of the hemorrhagic complication offer exceptions to the following statements. Without repeating

detailed discussions, the principal theoretical and therapeutic findings are as follows:

2. The failure of plasma injections in the most severe or advanced shock is confirmed. Simple saline solution is more effectual. Even if important, the restitution of blood proteins is strictly a secondary consideration, unrelated to the problem of immediate fatality from shock.

3. The universal teaching of the irreversibility of extreme shock is erroneous. In most of the above mentioned forms of experimental shock the process is reversible at all stages up to the instant of death.

4. The reversal by physiological salt solution comprises the following points: (1) Hemoconcentration and oligemia are replaced by hemodilution and apparently increased blood volume. (2) Anoxemia is corrected and sometimes overcompensated, as far as can be judged from the color of the blood. (3) Hypotension is replaced by a more or less sustained elevation of blood pressure. (4) Accordingly, diuresis is restored. (5) Symptoms are correspondingly improved, so that an animal which has ceased to breathe becomes restored to consciousness.

5. Quantitatively, the saline injections used for these purposes have been large, often one-fourth to one-half of the body weight. The most excessive injections are fatal through edema of the lungs, which constitute the weakest point in the circulatory system. Notwithstanding the pulmonary congestion of shock, dogs in advanced shock still tolerate the large saline infusions remarkably well, having one advantage over normal dogs in the increased permeability of capillaries in the traumatized area, which facilitates the escape of surplus fluid in the form of edema.

6. This marked tendency to edema with a large supply of salt solution is a test of capillary permeability. This test proves the local abnormality of permeability in the traumatized region and the absence of any such abnormality throughout the rest of the body.

7. Qualitatively, nothing has been found superior to plain physiological saline solution. While water and glucose solution have obvious value for dehydration, there is a distinction from shock; the fatal effect of a 5 per cent glucose injection in severe shock is evidently explained not by toxicity but by the need for electrolytes. Emphasis is placed upon sodium chloride. Any considerable quantity of any other anion than chlorine is probably fatal. Among cations, potassium was tested; and though its specific rôle in shock was disproved, the substitution of it for any considerable part of the sodium was detrimental and dangerous, for reasons which suggest a new phase of the pharmacology and toxicology of potassium. The behavior of Ringer solution was not noticeably different from that of plain saline. There is believed to be no possibility of preventing the pulmonary congestion and circulatory failure by alterations in either crystalloids or colloids.

8. In normal dogs, maximum intravenous saline infusions can produce dilution of the blood demonstrable for several hours after the stopping of the infusion, but within twenty-four hours elimination restores the blood to normal. In shock, two false doctrines have long had unquestioned acceptance: first, that injected salt solution is thus lost from the circulation without limit; second, that the washing out of plasma protein with the salt solution increases the hemoconcentration and the danger. Actually, when enough saline is given to fill the need or capacity of the tissues for fluid, a new equilibrium is established on the basis of an adequate circulating volume of dilute blood, and stable enough to persist for days or possibly weeks. The theoretical explanation is hypoproteinemia, due either to the escape of plasma into the huge edema of the "wheal," or to loss from the body in hemorrhage or burns.

9. As regards practical application, even the "moderate" injections which gave permanent recovery from fatal shock in dogs were larger in proportion to body

weight than any ever recorded in human shock treatment. Any powerful treatment is likely to carry risks, and the following considerations may be weighed pro and con:

(a) Human beings are more subject to edema than dogs; hence there may be danger in exceeding the quantities of saline already tried clinically.

(b) On the other hand, the possibilities of experimental benefits in dogs have been missed by previous observers to such an extent as to suggest that they may likewise have missed the clinical possibilities.

(c) When a method serves at least as a temporary cure, to the extent that an animal actually dying from shock or hemorrhage becomes able to sit up and to live for a day or more, the clinical possibilities are worth exploring.

(d) Obviously, some degrees of shock or hemorrhage may be too extreme to be curable, or they may require a treatment so extreme as to be fatal in itself; but time may be gained together with an opportunity for supplementary methods to combat the original injury or counteract the saline excess.

(e) Three rules were tentatively suggested for the treatment in dogs. First, shock is not necessarily checked by prevention of hemoconcentration, but it is checked when the hemoconcentration is prevented by saline injections. Second, shock should be treated conservatively as a self-limited disorder, in the sense that if life is preserved through a short critical period recuperation will follow. Third, the quantity of salt solution which just suffices for this purpose and for a moderate limit of hemoconcentration can be safely tolerated by the organism. These suggestions cannot be positive until they are tested as to both efficacy and safety.

(f) This treatment of shock is most promising in constitutionally sound individuals such as young laborers and soldiers. It may be limited or contraindicated by complications such as cardiorenalvascular disease, hypoproteinemia or senility, also in any condition in which the exaggerated

local outpouring of fluid in the injured area may be dangerous.

(g) The clinical fact that patients sometimes live through a long chronic course of quite extreme hydremia and edema suggests that the human organism may likewise tolerate such a condition when produced acutely and artificially.

(h) In dogs, there is a considerable zone of abnormal but fairly stable equilibrium between fatal shock or hemorrhage on the one hand and fatal pulmonary edema on the other. The limits of this zone with saline injections in human patients can be learned only by clinical trials.

(i) Salt solution has the practical advantage of prompt and unlimited availability. An incidental saving of plasma may be important.

The general conclusion regarding practical theory, therefore, is that careful trials of the proposed method are proper in cases which are hopeless under orthodox treatment. If any benefits are revealed by such trials, it is hoped that they may still find some slight application at this late stage of the war.

10. In general theory, the specific relief of shock by salt solution may be attributed to: (1) the supply of fluid which can pass readily through bloodvessel walls to form the "wheal" which is an obligatory consequence of trauma; (2) the establishment of a new physicochemical equilibrium between blood and tissues, perhaps as compensation for the altered capillary permeability; or (3) the specific physiological rôle of sodium chloride in relaxing small blood vessels, raising blood pressure, adjusting exchanges between blood and tissues, and other circulatory-metabolic functions which are still unexplored. The apparent inferiority of plasma injections for elevating blood pressure and producing oxygenation of the venous blood tends to emphasize the third interpretation. The results in shock thus fit in with other studies which the writer has long and vainly attempted to make on hypertension, renal-vascular and related circulatory problems.

Too many investigators in the past have undertaken to decide rigidly whether shock is due to fluid shift or intoxication. There is proof that the fluid factor alone can be fatal. But all the consequences of fluid shift, including most of the chemical and physiological phenomena on which studies and definitions of shock have been based, can be relieved by simple saline injections as described above. In the severest shock this cure is incomplete or temporary, and death is merely delayed for important periods such as twelve, twenty-four or thirty-six hours. It is, therefore, necessary to study the deeper process of shock, namely, whether the final pulmonary congestion and death are due to continuing circulatory failure, or toxic or other unknown causes. The combination of fluid replacement with local refrigeration of the shock-producing area (when feasible) seems to offer the best practical treatment, and this influence of refrigeration appears to favor the toxic theory. An advance beyond these two available therapeutic methods must presumably consist in a means of overcoming the specific toxin, either by the antitoxin liver substance announced by Prinzmetal or by some other discovery along new lines.

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**Addendum.** Recently, saline infusions have been found ineffectual for a few exceptional dogs in the terminal apnea of shock. According to this small experience, absence of hemoconcentration indicated by red cell counts is a sign that saline treatment will fail, while the much larger experience with marked hemoconcentration illustrated in the published tables signifies that such dogs can be revived by saline without exception. Various authors using various methods have described shock with and without hemoconcentration. It is more surprising that such differences can occur with the seemingly identical

method of tourniquet application. Minor differences, such as the tightness of the tourniquet and the degree of swelling of the legs, seem to be the most probable explanation of these discrepancies and likewise of the negative saline results of Swingle and co-workers (*Am. J. Physiol.*, 138: 156-165, 1942-1943). These exceptions do not disturb the essential conclusion of the superiority of saline over plasma (confirmed by Rosenthal), and the resuscitation of dogs dying with extreme shock and hemoconcentration can be demonstrated to any interested persons.



# RECURRENT INCARCERATION OF LEFT INTERSTITIAL INGUINAL HERNIA\*

L. ALBERT THUNIG, M.D.

Attending Surgeon, St. John's Hospital

BROOKLYN, NEW YORK

MUCH has been written concerning interstitial hernias and among the later reports the article by Lower and Hicken based upon two cases and an analysis of the literature with two and one-half pages of references is quite complete.<sup>1</sup> In order, however, to demonstrate the place occupied among these rather unusual types of hernias and to show how our case conformed with or differed in its main clinical and anatomical aspects from similar cases, it is necessary to quote freely from the literature. My comments shall be listed under the following headings: (1) Classification, (2) history and frequency of occurrence, (3) etiology, (4) important anatomical variations of the sac, (5) difficulties of diagnosis, (6) usual clinical picture, and (7) treatment and prognosis.

## CLASSIFICATION

The classification given below is now generally accepted and quoted by essentially every author of papers on interparietal or interstitial hernia. I can find essentially no change in the names of the various types since 1876. Interparietal hernias include all the types of hernias mentioned in the following groups and, as the name indicates, represents those hernias in which the sac does not follow the usual course of the sac found in ordinary inguinal hernias but lies between the various parieties of the abdominal wall.<sup>2</sup>

*Proprietoneal.* The sac lies between the peritoneum and the transversalis fascia. The sac usually is directed upward toward the anterior superior spine, sometimes toward the bladder, rarely toward the obturator foramen.<sup>3,4</sup>

Inguino-interstitial. (1) The sac lies between the transversalis muscle and transversalis fascia. (2) The sac lies between the transversalis muscle and internal oblique muscle. (3) The sac lies between the internal and external oblique muscles. Wilensky and Gordon mention an additional rare type in this group in which the sac lies between the fibers of the internal oblique muscle.<sup>5</sup>

Inguino-superficial. The sac lies between the external oblique muscle and superficial fascia. Iason<sup>6</sup> and Lower and Hicken<sup>7</sup> mention three types in this superficial group: (1) The sac going laterally to anterior superior spine; (2) the sac going upward and medially; (3) the sac going downward over the femoral ring between the skin and deep fascia.

The hernia discussed in this paper belonged to Type 2 in the inguino-interstitial group; in other words, it was a hernia with the sac lying between the internal and external oblique muscles.

## HISTORY AND FREQUENCY OF OCCURRENCE

Göbell<sup>8</sup> gives us the following historical facts: According to Macready,<sup>9</sup> Bartholin<sup>10</sup> gave the first case report in 1661. Later in 1797 Petit entered the literature of interparietal hernia. Inguino-interstitial hernia was first so termed by Goyrand in 1835.<sup>11</sup> Küster, in 1886, described three cases of superficial inguinal hernias under that name and since then this type of hernia has at times been termed "Küster's Hernia,"<sup>12</sup> Krönlein's excellent study and report of 1876 with his collection of cases<sup>13</sup> is, of course, also referred to by Göbell and by

\* From the Surgical Division of St. John's Hospital, Brooklyn, New York.

numerous more recent writers of which I shall refer to only one.<sup>14</sup>

As to the frequency of occurrence,

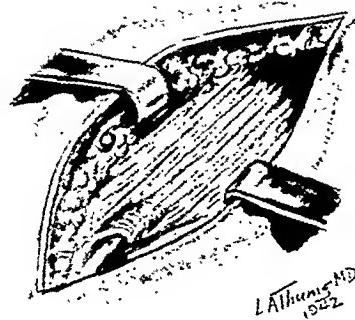


FIG. 1. Appearance at first operation June 10, 1940. Normal, innocent looking aponeurosis of external oblique with small tight external inguinal ring.

Krönlein states that up to 1864 he found only fourteen reported cases and that up to 1880 he could collect only nine more.<sup>15</sup> More recently case reports have become more frequent: Lower and Hicken collected 587 cases with the comment that the condition is still spoken of as being rare. There were in their collected cases 119 of the properitoneal group, 348 of the interstitial group and 123 of the superficial group.<sup>16</sup> These total 590 but are the exact figures as given by Lower and Hicken.

Regarding sex, in Krönlein's twenty-three cases there were twenty-two males and one female.<sup>17</sup> Cunston,<sup>18</sup> who reviewed Göbell's 115 cases states that there were only four females in the series and comments that in the experience of most men interparietal hernias in the female are rare. Watson mentions the fact that Langton collected forty-two interstitial hernias in 50,000 inguinal hernias in the male.<sup>19</sup> Lower and Hicken quote the following ratios between male and female in the three various groups of interparietal hernias: in the properitoneal group (cases reported since 1900) there were thirty-three males and nine females;<sup>19</sup> in the interstitial group in Macready's 163 cases there were 129 males and thirty-four females; in the

own collected cases 285 men and eighty-two women,<sup>19</sup> in the superficial group 101 men, seven women and fifteen cases in which the sex was not stated.<sup>19c</sup> Thus, the ratio of cases in the female to cases in the male varies from the incidence of 4 to 111 or 1 to 27 plus, the lowest incidence in female cases, to 1 to 3.4 plus, the highest incidence in female cases. The first ratio of 1 to 27 is in interparietal hernias in general, the second of 1 to 3.4 occurred in the interstitial group of interparietal hernias. One may state very definitely that interparietal hernias are less common in the female sex.

#### ETIOLOGY

The theory of some obstructive condition in the inguinal canal as a factor in the production of interparietal hernias is given by Göbell<sup>20</sup> and Kronlein<sup>21</sup> and both of these men mention, among other factors, the part played by undescended testes. Mechanical obstruction such as an undescended testicle was present in about 70 per cent of all reported cases of interstitial hernias.<sup>22</sup> Watson states that interparietal hernias which include all other types usually occur in the male with undescended, improperly descended or malformed testes.<sup>23</sup> Halstead also comments upon this fact.<sup>24</sup> Viewed from the standpoint of undescended testes Beigler and O'Brien quote Coley as reporting that twenty-six out of 123 cases of undescended testes showed the inguino-superficial type of interparietal hernia.<sup>25</sup> A small external ring is given as a predisposing factor and an external ring closed by adhesions due to a faulty fitting truss is also held responsible.<sup>26</sup> Hydrocele in the canal of Nuck was found in at least one reported case.<sup>27</sup> That interstitial hernia may arise as a postoperative hernia is shown in the case reported by Dunphy in which the hernia arose from the drainage site of an old appendectomy and the sac dissected between the internal and external oblique muscles.<sup>28</sup>

In the case herewith presented the patient was a woman. Obviously, ectopic

testes need not be considered. The patient at her first admission had no inguinal or abdominal scars; she had no hydrocele of the canal of Nuck, but she did have a very small and a very tightly closed external ring. No other obstructive factor was found at the first or second operation. (Fig. 1.)

#### IMPORTANT ANATOMICAL VARIATIONS OF THE SAC

Moynihan<sup>29</sup> and Halstead<sup>30</sup> have contended that bilocular sacs must be present in interparietal hernia. Lower and Hicken have shown that two sacs are present in the majority of cases.<sup>31</sup> Wilensky and Gordon, however, state that about one-third of the cases reported had monolocular sacs.<sup>32</sup> In the event of the two sacs one sac is commonly located in the inguinal canal or scrotum the other in any of the locations constituting an interparietal hernia.<sup>33</sup> Watson states, in speaking of the properitoneal type of interparietal hernia that the sacs are usually bilocular. The outer portion which is often empty may be in the inguinal canal or very rarely in the femoral or between the layers of the abdominal wall, as in the interstitial or inguino-superficial types.<sup>34</sup> In bilocular sacs the shape is always hour-glass and there is always a common opening into the abdomen at the neck of the sac.<sup>35</sup> As I understand it the bilocular sacs, as described in the literature, really represent a diverticulum of the primary sac due to the fact that the primary sac is impeded in its progress.

In my case there was one well defined sac with intestinal content. It arose just below the lower border of the internal oblique, dissected upward between the external and internal oblique muscles and left the lower part of the inguinal canal empty and the external ring small and tight. (Figs. 3, 4 and 5.)

#### DIFFICULTY OF DIAGNOSIS

In presenting my case I stated under the interns' examinations upon her first ad-

mission to the hospital on June 8, 1940, one believed that the patient had an ovarian cyst with a twisted pedicle and the second

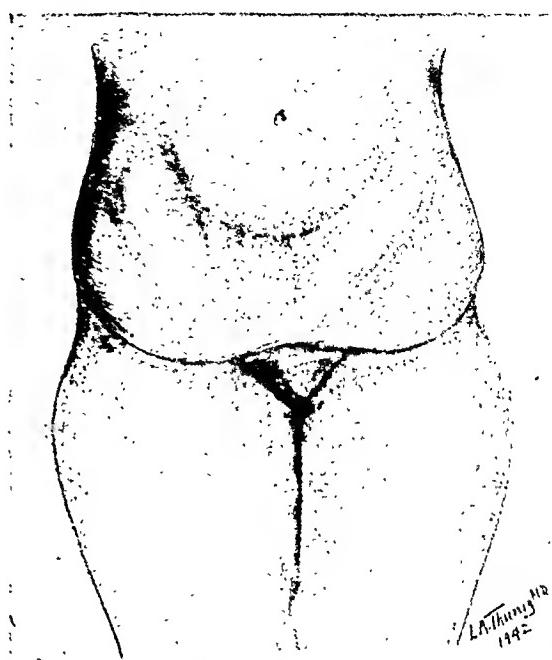


FIG. 2. Appearance of abdomen November 28, 1940. Scar from operation in June. Bilateral fat aprons and bilateral bulging of relaxed aponeurotic wall of lower abdomen but no hernia.

intern that she had a twisted dermoid or subserosal fibroid. These conclusions by the interns were based entirely upon the symptoms and abdominal findings; no pelvic examination had been made at that time. While we now know in retrospect that the pain and vomiting present on her first and third admissions were due to incarceration and hence the early symptoms of obstruction, time did not allow for definite symptoms of obstruction to develop. On her first admission the hernia had spontaneously and completely reduced itself within three hours or less after admission or less than eighteen hours after its acute onset and on her last admission an emergency operation relieved the condition two and one-quarter hours after admission or eight and one-quarter hours after its sudden onset. Hence the pain and vomiting on her first admission did not differ essentially from the pain and vomiting which might usher in any

acute abdominal or pelvic catastrophe. However, in spite of these extenuating circumstances, some may consider the

hernia, especially the properitoneal type.<sup>36</sup> Watson states that the diagnosis is seldom made preoperatively in properitoneal inter-

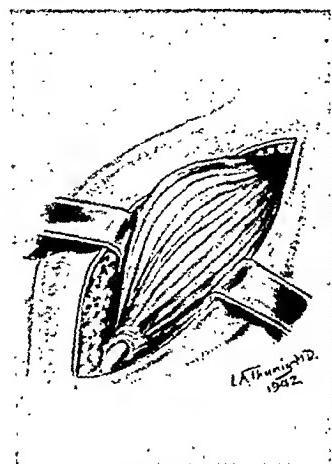


FIG. 3.

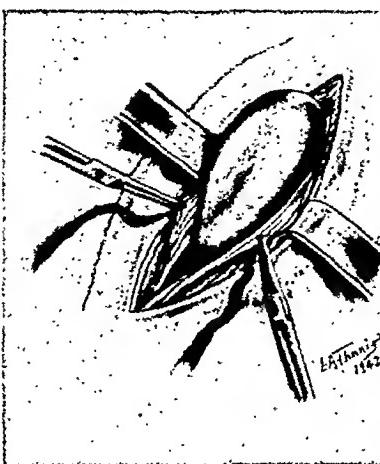


FIG. 4.

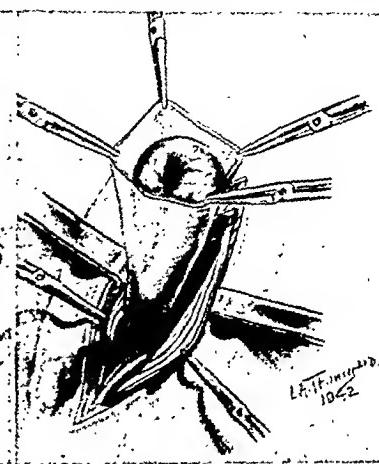


FIG. 5.

FIG. 3. Appearance of aponeurosis of external oblique at second operation October 18, 1941. External ring still small and tight; marked bulging above the level of the internal ring; lower inguinal canal not distended.

FIG. 4. Aponeurosis of external oblique cut, unattached sac lying on internal oblique; tip of sac considerably higher than internal ring.

FIG. 5. Sac delivered and opened showing intestinal content.

diagnoses of the two interns, who were both good men, as entirely inexcusable. But when one reviews even a small number of cases one is impressed by the idea that there must be something about the physical characteristics of these interstitial hernias that makes exact interpretation by palpation difficult and frequently deludes one into the idea that the mass present is intra-abdominal or even retroperitoneal. Such delusions in interpretations of tactile sense are also present in other lesions. Far afield from interstitial hernia, but illustrative of deluded sensory tactile impressions is the impression of depressed fracture of the skull so often obtained by palpation of some large hematomas of the scalp. Many a surgeon has been so positive about this finding that an exploratory examination has been done only to find a hematoma and nothing more. The point which I wish to make is that cortical sensory tactile impressions unaided or unguided by the other senses are at times entirely different from the actual existing state of affairs.

In 1880, Krönlein commented upon the difficulty of diagnosis of interparietal

parietal hernias, that interstitial hernias are easier but that strangulated interstitial hernias are often mistaken for appendicitis.<sup>37</sup> Wilensky and Gordon report in their case: "The original opinion of the visiting staff" (medical service) "was that there was an intra-abdominal tumor, probably a neoplasm in the sigmoid," and ". . . the operator feeling that the most likely diagnosis was a tumor in the abdominal wall."<sup>38</sup>

Dunphy speaking of his case No. 1 remarks: "The diagnosis on admission was intestinal obstruction due to a neoplasm of the sigmoid." In regard to case No. 2 he stated: "At first it seemed to be a retroperitoneal, but physical examination suggested that the lesion might be more superficial." Dunphy states that both of these cases were diagnosed correctly preoperatively but he does not report them under interparietal hernias even though he discusses interparietal hernias in the paper. He also states that many cases are overlooked or mistaken for abdominal or retroperitoneal tumors.<sup>39</sup>

"The inability to diagnose correctly and the high mortality rate indicate how

superficial our knowledge is in these cases."<sup>40</sup>

Many suggestions to aid in the diagnosis of interparietal hernia appear in the literature a few of which are the following:

"The following co-existing conditions should make one suspect the possibility of interparietal or interstitial hernia when the diagnosis is otherwise obscure: 'Cases presenting obstructive symptoms associated with an abnormally placed testicle and a palpable mass above Poupart's. In other cases without the above combination of symptoms and signs the diagnosis may be difficult or impossible. In the presence of a mass alone, a differential diagnosis between diverticulum of the intestine, neoplasm of the intestine, tumor of the abdominal wall and interstitial hernia may be as difficult as our experience in this case shows.'"<sup>41</sup>

"The symptoms of superficial hernia are usually those of intestinal obstruction. . . . In this type a palpable tumor is encountered above Poupart's ligament and when the scrotum is examined the testicle is missing. It must be remembered, however, that in a few cases the superficial sac may pass downward into the region of the femoral ring and be mistaken for a femoral hernia."<sup>42</sup>

". . . of and in the diagnosis of interstitial hernia is the association of a hernia extending above the site of the internal ring, an ectopic testicle and symptoms of intestinal obstruction."<sup>43</sup>

A very good reason as to why the diagnosis is seldom made is very ably and candidly expressed by Beigler and O'Brien as follows: "When we see patients who present themselves with inguinal hernias, we are usually accustomed to classify them as either direct or indirect. It is seldom that we make a pre-operative diagnosis other than the above types, largely because we fail to recognize any other type of inguinal hernias. This failure of recognition is probably due to the fact that most of us are unaware of the existence of inguinal hernias other than the usual type."<sup>44</sup>

In the case presented in this paper the author vaguely suspected a direct left inguinal hernia which he believed had reduced itself spontaneously. These were his preoperative impressions. After the first operation he was firmly convinced that no hernia of any kind was present and that the vague impression of intestine and peristalsis in the abdominal wall which he believed he had experienced pre-operatively must have been due to some intra-abdominal condition. Had he been interstitial-hernia minded, even in spite of apparently negative findings, he would have split the aponeurosis of the external oblique and in all probability (unless the sac was also completely reduced) the true state of affairs would have been revealed. On the second admission the patient presented the mass on the left and with the symptoms of pain and vomiting the author believed that an incarcerated hernia must be present in spite of his negative exploratory findings at the first operation. (When the author saw the patient for the first time on her first admission the mass described by the interns had disappeared.)

#### USUAL CLINICAL PICTURE

The usual clinical picture is that of intestinal obstruction. This is obvious when one realizes that most of these patients present themselves when the acute symptoms develop and according to Cumston at least 50 per cent of Göbell's cases had already strangulated.<sup>45</sup> Wilensky and Gordon and Lower and Hicken state that in Göbell's series of 115 cases there were ninety-seven incarcerations.<sup>46,47</sup>

Obstructive symptoms, however, may be absent as in the cases reported by Wilensky and Gordon,<sup>48</sup> Beigler and O'Brien,<sup>49</sup> Lower and Hicken<sup>50</sup> and Edington.<sup>51</sup>

In the case herein reported, although the mass, vomiting and pain had completely disappeared when I saw the patient on her first admission, she did have obstructive symptoms regardless of how they were interpreted when she entered the hospital. The subsequent history of the case proves

that. The spontaneous and practically complete reduction of an incarcerated interstitial hernia is apparently uncommon and noteworthy, especially in view of the fact that most of these hernias go on to strangulation. On her third admission there was no question preoperatively about obstruction due to incarceration nor regards the existence of a hernia; that it was an interstitial hernia was not, however, suspected.

#### TREATMENT AND PROGNOSIS

Early operation, whether symptoms of incarceration or strangulation are absent or present, is advocated without exception. The procedures advocated are either by the direct inguinal route with careful separation of the sac, careful search for a second sac, ligation and ablation of sac and closure by any one of the many standard procedures, or by a combined abdomino-inguinal procedure as advocated by Moynihan and seconded by Lower and Hicken on the grounds that the site of the obstruction is more clearly revealed and intestinal injury thus precluded.<sup>52</sup> In the case presented a simple Bassini closure was used.

Krönlein, in 1880, stated that because of difficulties in diagnosis and the resultant delay in operation especially in the strangulated properitoneal type the prognosis is decidedly bad.<sup>53</sup> Both Edington<sup>54</sup> and Beigler and O'Brien<sup>55</sup> state that Krönlein reports a mortality of 90 per cent in all cases of strangulated interstitial hernias. I have been unable to find that figure in a perusal of Krönlein's articles. While the prognosis in later case reports in non-incarcerated and non-strangulated interparietal hernias does not appear alarming, it is generally conceded that the prognosis in the strangulated hernias is bad and the mortality rate high; delay in operation due to difficulties in diagnosis appears to be the determining factor.

The case herewith reported had an entirely uneventful postoperative course and recovery.

#### CASE REPORT

R. L., a forty-two year old female, married (N.-4573), was admitted to the hospital at 2:15 P.M., June 8, 1940, with the complaints of pain in the lower left quadrant, nausea and vomiting of fourteen hours' duration. The past and family histories were irrelevant.

Three months previously the patient had noticed a non-painful and non-discomforting mass in the left lower quadrant. On June 7th, at 10 P.M. she experienced sudden, intense epigastric pain and one-half hour later became nauseous and vomited. During the night the pain migrated to the left lower quadrant and the mass had doubled in size. She vomited twice in the morning of June 8th. She had completed her last regular menstrual period on June 6th.

The interns' examination and impression on admission were: "Round protruding mass about 6 cm. in diameter in left lower quadrant. Mass is not tender but tenderness is present in epigastric area. There is moderate spasm of the muscles over the mass. The attachment of the mass cannot be determined." One intern believed it to be a twisted dermoid or twisted subserosal fibroid; the other intern thought it was an ovarian cyst with a twisted pedicle.

I saw the patient at about 7 P.M. at which time she did not appear acutely ill; as a matter of fact, she was very comfortable. No mass was present. The abdomen and pelvis were essentially negative. In the left inguinal area, however, one got the very vague sensation of the presence of intestine in the abdominal wall with what seemed to be peristalsis on palpation. The opinion was ventured that the patient had had an incarcerated, direct, inguinal hernia which had almost completely reduced itself. The patient's temperature was 98.6°F., the pulse 80, urine negative and white cell count 9,350 with 70 per cent polymorphonuclears, 24 mature and 46 immature types.

At the first operation on June 10th, an incision was made parallel to Poupart's ligament but intentionally made higher than the usual incision for inguinal hernia to allow further exploration of the abdominal wall in the event that the diagnosis of inguinal hernia proved incorrect. The external ring and aponeurosis of the external oblique were widely exposed. The external ring was tightly closed. The aponeurosis of the external oblique showed no weak areas and palpation along the inguinal canal

gave no evidence of anything abnormal. (Fig. 1.) The lower flap of the incision was now dissected below the level of fat and subcutaneous tissues and superficial fascia well down below Poupart's ligament and the femoral ring exposed; this was perfectly normal. The upper flap of the incision was dissected in similar fashion over the linea alba and up to the umbilicus so that with good traction these areas were well exposed; no evidence could be found of any opening or herniation anywhere. When the operation was completed I was very certain that the tentative diagnosis of direct inguinal hernia was entirely incorrect and that the vague impression of intestine in the abdominal wall and the suspicion of peristalsis were likewise false impressions and probably caused by some temporary intra-abdominal condition. I was certainly very certain that no hernia of any kind existed and in view of these facts offered the very flimsy and highly fantastic diagnosis of phantom tumor, a tumor which in this case I never saw nor felt.

The patient made an entirely uneventful recovery with complete absence of gastrointestinal disturbance, the wound healed by primary intention and the patient was discharged June 16, 1940, six days postoperatively.

The patient was seen in the out-patient department on June 20, 1940, and was complaining of hemorrhoids. The examiner at that time made no comment about the left lower abdominal quadrant except to state the wound was well healed. One June 29th, she was seen again and complained of gas. The examiner noted that there was slight bulging on pressure, presumably intra-abdominal pressure. On November 28, 1940, I personally examined this patient. Knowing her history and my operative experience I examined her very carefully. She was moderately obese with a slight roll of abdominal fat which on standing formed two lateral small fat aprons. With increased intra-abdominal pressure there was a bilateral area of fullness corresponding to the aponeurotic portion of the lateral abdominal muscles, a condition often observed in both males and females with poor abdominal muscle tone. Careful inspection failed to reveal any actual hernia. (Fig. 2.) Questioning failed to elicit the fact that any mass had reformed in the left lower quadrant since her discharge from the hospital.

On December 10, 1940, she was admitted to the gastrointestinal service and operated upon for hemorrhoids and discharged December 16th. The intern's examination report among other things mentions the obese abdomen, the rather high inguinal scar but nothing about any mass or hernia.

This patient was again seen in the out-patient department on December 28, 1940, and January 10, 1941. On these two occasions the examiners commented upon the condition of the anus. There was no comment about the inguinal areas and presumably the patient made no complaints pertaining to same. This patient was not seen again until ten months after her hemorrhoidectomy and about sixteen months after her exploratory operation for suspected hernia, when she was again admitted to the hospital.

At 3:45 A.M. October 18, 1941, this patient was readmitted with complaints of pain and mass in the left lower quadrant, nausea and vomiting of six hours' duration.

She had been quite well since her last admission with the exception of the occasional appearance of a mass in left lower quadrant for the last year. (This patient was last seen in the out-patient department about nine months and eight days prior to the third admission but she had not complained of the mass at any visit after her original operation of June 10, 1940, so there is a discrepancy of about two months' time which may be due to either a failure of the patient to mention the appearance of a mass or a carelessness on her part in the statement of time. On the other hand, it is possible that the patient may have casually mentioned it to one of her several examiners who because of interest in some other part of her anatomy failed to make mention of it. I can state with certainty that when I saw the patient on November 18, 1940, she had no visible or palpable mass nor did she complain of any such occasional occurrence of a mass.) At 1 A.M. October 18, 1941, she developed sudden pain in the left lower quadrant followed by the appearance of the mass, nausea and vomiting followed. Her bowels had moved the previous day. Examination and impression of intern was: "Rather high inguinal scar, a mass the size of a lemon is present in the left lower quadrant above Poupart's ligament; it is not reducible, there is an impulse on coughing and a dull note on percussion. Impression: incarcerated left in-

guinal hernia." I saw the patient a very short time after admission and for the first time saw the mass which had been described to me sixteen months previously. My findings agreed with those of the intern and I was fully agreed that it must be an incarcerated hernia in spite of my negative operative findings on June 10, 1940.

At 6 A.M. October 18, 1941, with the pre-operative diagnosis of incarcerated inguinal hernia the patient was operated upon. An incision was made parallel to Poupart's ligament just below the scar of the operation of June 10, 1940. The external ring and the aponeurosis were widely exposed. The external ring was firmly closed. The aponeurosis of the external oblique was intact but a mass about the size of a lemon could be felt beneath the aponeurosis high above the external ring. (Fig. 3.) The aponeurosis of the external oblique was split from the external ring to a point well above the upper level of the mass and a distended sac the size of a lemon was found arising from a narrow neck through a small opening low in the inguinal canal. It could not be definitely determined without unwarranted dissection whether the opening was just below the free border of the internal oblique or through some of the fibers of the lower border of the internal oblique, and the relation to the deep epigastric artery was not determined. The sac lay between the aponeurosis of the external oblique muscle above and the internal oblique muscle below. The sac was practically free of adhesions to the adjacent tissues and was easily lifted out of its bed. (Fig. 4.) Upon opening the sac a moderate amount of thin serous fluid made its escape and a moderately distended loop of small intestine in excellent condition was found. (Fig. 5.) The gut was not adherent and was easily reduced even though the neck of the sac was narrow and the hernial opening small but dilatable. The sac was ligated, cut off and the stump transfixated to the undersurface of the internal oblique. The internal oblique was sutured to the lower shelf of Poupart's without transplantation of the round ligament. The aponeurosis of external oblique was sutured tightly. Postoperative diagnosis: Incarcerated interstitial inguinal hernia.

The postoperative course was uneventful. She was discharged October 28, 1941. When re-examined in the out-patient department

February 19, 1942, the wound was well healed; there had been no recurrence, and the patient was symptom free.

#### CONCLUSIONS

1. Interparietal hernias in general and even the more common group of same, the inguino-interstitial types, though they cannot be considered rare, are still uncommon, especially in women.
2. This case like many others was deceptive from the standpoint of palpation of the mass.
3. This case differed from most others in the following respects: (1) With incarceration and the early symptoms of intestinal obstruction present, the hernia suddenly reduced itself completely and the patient became symptom free. (2) For sixteen months the patient enjoyed good health and for the greater part of this time she had no mass in the left inguinal region. (3) At the expiration of sixteen months after her first incarceration she became acutely incarcerated again and was cured by operation.
4. This case was completely muffed by the author at the first operation simply because he was not interstitial-hernia minded and failed to incise the innocent and normal looking aponeurosis of the external oblique.
5. The author hopes that other surgeons as yet not confronted by their first interstitial hernia may become interstitial-hernia minded and thus avoid the error of omission committed by the author in the case just presented.

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# CONTROL OF POSTOPERATIVE PAIN

## APPLICATION OF COLD TO THE OPERATIVE SITE

EARL G. KRIEG, M.D.

Senior Attending Surgeon, Woman's Hospital

DETROIT, MICHIGAN

THE empirical control of pain by thermal methods is as old as time.

During the last few years the experiences of F. M. Allen, Brooks and Duncan, N. K. Neuman and others have shown that by means of low temperatures pain can be controlled even at surgical levels. These authors have further shown that with the proper technic there is no interference with the healing or preservation of tissues by these low temperatures for relatively long periods of time.

For some time I have been interested in the control of postoperative pain by means of the application of ice caps to the operative area. The aim of this procedure has been the substitution of cold for narcotic drugs either in whole or in part. Our initial experience involved a patient who required appendectomy and who was violently allergic to all opium derivatives. Her postoperative pain was entirely controlled by the application of ice caps. Since then further interesting observations have been made.

The temperatures induced by the application of bare ice caps is approximately 6°C. There has been no evidence of any interference with wound healing in any of our cases.

The efficacy of the ice cap is attested to by the reduction in the amount and the type of narcotic actually required. After preliminary experience it was found that codeine sulfate in 1 gr. dosage was sufficient to control the residual pain in all except the occasional individual. In this series 20 per cent of the adults and 70 per cent of the children required no narcotic. In the last sixty-seven consecutive cases the average number of hypodermic injections of 1 gr.

of codeine sulfate given postoperatively has been less than two and in no instance has the hypodermic been given oftener than every ten hours.

Coincident with the reduction in the amounts of narcotic administered there has been an apparently abrupt fall in the complications attributed to anesthesia and/or operation. This is not at all surprising when one reviews the pharmacology of the opium derivatives with the postoperative picture in mind. We hope to report upon this aspect of postoperative care when our series is sufficiently large.

The method is simple and its two component parts have been used by others in various ways. The dressing consists of a double thickness of cellophane sealed to the skin by wide strips of adhesive tape thus providing a water-proof dressing of good conductivity. Miss E. Anderson, operating-room supervisor at Woman's Hospital, has found after considerable experimentation that the cellophane should be of the thickness of that commonly used for oxygen tents and that handling is best accomplished by wrapping in cloth as a flat package which is sterilized in the autoclave.

The second part consists of one or more ice caps without the usual flannel jacket. The bare cap is placed directly upon the cellophane immediately after operation. In order to be effective the cold must be applied for at least one-half hour. The contents of the ice cap must be renewed as frequently as the ice disappears because ice water alone is not effective. In this series hypodermic administrations of codeine were most frequently administered just after an operation performed under

spinal analgesia which had subsided before the ice became effective and during the night when the nurse did not fill the ice

cases only; morphine sulfate in  $\frac{1}{6}$  gr. dosage was used only twice in the last one hundred odd cases. Spinal analgesia was

TABLE I  
(ADULTS) KIND AND AMOUNT OF NARCOTIC GIVEN DURING THE POST-OPERATIVE PERIOD

Operation	No. of Cases	No. Nar- cotic	Morphine Gr. $\frac{1}{4}$						Morphine Gr. $\frac{1}{6}$						Codeine Gr. 1													
			1		2		3		4		5		Over	1		2		3		4		5		6		7		Over
			1	2	3	4	5	Over	1	2	3	4	5	6	Over	1	2	3	4	5	6	7	Over	1	2	3	4	5
Appendix.....	75	23	3	4	1	4	3	1	1	4	3	1	...	1	12	9	1	4	...	1	1	1	1	1	1	1	1	1
Gallbladder.....	13	...	...	...	1	1	1	1	1	1	1	1	...	...	1	2	1	1	1	1	1	1	1	1	1	1	1	1
Gastrointestinal resections.	8	...	...	1	...	...	...	...	...	1	...	1	...	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1
Hysterectomy (abd.).....	5	...	...	...	...	...	1	...	1	...	1	...	1	...	...	1	1	1	1	1	1	1	1	1	1	1	1	1
Hysterectomy (vag.).....	6	1	...	...	1	...	2	...	1	...	1	...	1	...	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Colostomy.....	1	...	...	...	...	...	...	...	...	...	...	...	...	...	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Breast (radical).....	4	1	...	...	...	...	...	...	...	...	...	...	...	...	...	1	1	1	1	1	1	1	1	1	1	1	1	1
Breast (simple).....	5	...	...	2	...	...	...	...	...	...	...	...	...	...	...	1	1	1	1	1	1	1	1	1	1	1	1	1
Thyroid.....	2	1	...	...	...	...	...	...	...	...	...	...	...	...	...	1	1	1	1	1	1	1	1	1	1	1	1	1
Salp-ooph. Suspension, etc.																												
Append. (25).....	33	...	1	...	1	...	1	...	...	1	1	...	2	1	1	2	1	2	3	6	5	2	5	1	2	1		
Finger (incision and drainage).....	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	1	1	1	1	1	1	1	1	1	1	1	1	1
Bilateral varicocele.....	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	1	1	1	1	1	1	1	1	1	1	1	1	1
Hernia.....	30	8	...	...	...	...	...	...	6	1	1	1	...	...	...	...	...	8	2	3	...	...	...	...	...	...	...	
Totals.....	185	36	4	4	4	7	4	5	8	7	7	4	3	2	4	28	19	15	11	3	6	2	3	...	...	...	...	...

caps for fear of disturbing the patient. The ice must be replaced from one to three hours. In the average case the ice cap may be discarded after the second day.

TABLE II  
CHILDREN (FOURTEEN YEARS AND UNDER)

Operation	No. of Cases	No. Nar- cotic	Codeine $\frac{1}{2}$ Gr.			
			1	2	3	4
Appendix.....	9	5	1	2	1	1
Hernia.....	6	5	1	1	1	1
Intussusception.....	3	2	1	1	1	1
Pyloric stenosis.....	3	3	1	1	1	1
Totals.....	21	15	3	2	1	1

Table I plots the operation and the kind and number of doses of narcotic used in the adult cases. Morphine sulfate in  $\frac{1}{4}$  gr. dosage was used in the first twenty-eight

most frequently used in the operations requiring average operative time; the operations of longer duration or of minor severity were performed under nitrous oxide combined with local and splanchnic block when necessary. Suture material of choice in the clean cases was fine silk, in the infected case, fine catgut.

Table II is similar to Table I and represents children under fourteen years. Babies and the younger children received the sedation in the form of suppositories. Open drop ether anesthesia was used in all except those having pyloric stenosis.

#### SUMMARY

The substitution of a thermal method for the administration of narcotics in the control of pain is of general surgical interest and especially when operations are performed upon the aged, the allergic and the badly injured in civil and military practice.

I am particularly indebted to the nursing staffs of the various hospitals in which these

patients were treated and to Dr. W. S. Lovas and Dr. M. D. MacCauley now in the military service for their assistance in this work.

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FIBROMA of the ovary is a relatively common growth, but not nearly so common as the cysts. It occurs usually in women less than 25 years of age, frequently at the age of 18 or 19, and is often bilateral.

From "Essentials of Gynecology" by Willard R. Cooke (J. B. Lippincott Company).

# THE USE OF WATER SOLUBLE CHLOROPHYLL IN ORAL SEPSIS\*

AN EXPERIMENTAL STUDY OF 300 CASES

S. L. GOLDBERG, D.D.S.  
CHICAGO, ILLINOIS

THE fundamental biologic relationship of pathologic states occurring in the oral cavity to those found elsewhere in the body is all too frequently overlooked by dentist and physician alike. Nowhere is this more true than in respect to the infectious lesions of the teeth and their supportive tissues.

The treatment of infections of the mouth, in general, has been based upon one of two methods of approach, either separately, or in combination; (1) the indirect or immunological and (2) the direct, or chemotherapeutic. In the former, treatment has been directed toward the enhancing of the natural resistance of the body against the infective agent by supplementing these normal but somewhat indefinable factors with more or less specific artificially produced immunological agents —antisera, vaccines, antitoxins, etc. In the latter, the greatest emphasis has been placed upon the local, topical use of antiseptic agents to destroy the infectious agent *in situ*. At times this has been supplemented by the use of drugs systemically, administered either by mouth or parenterally. Only too often the antiseptic employed, while effective in destroying the infectious agent in a certain relatively small percentage of cases, causes simultaneously such extensive damage to the tissues either through the inherent powerful action of the drug, or through its necessarily vigorous and thorough application, that they are left in a relatively poorer state of nutrition than before treatment was instituted. This in turn delays proper healing and leads to reinfection, especially

when there co-exists some unrecognized, more or less asymptomatic, latent, systemic disorder such as subclinical vitamin deficiency state.

In the treatment of infections of the oral cavity using antiseptics, alone or fortified by various immunologic products, we are faced with peculiarly discouraging results because of the absolute impossibility of maintaining bacterial sterility during the reparative phase following the initial infection. Our methods up to the present time, at best, have only been relatively palliative in character, leaving to nature the ultimate eradication of the infection, and healing of the lesion. Consequently, in the majority of cases, a state of subacute or chronic infection persists, which, although clinically not active, is merely in temporary abeyance, and can flare up again at any time under relatively slight provocation. Many instances of this fact could be cited of which two examples may serve to illustrate the point.

1. The frequency with which Vincent's stomatitis is seen is vitamin c deficiency suggests a latent infection of the tissues, activated from time to time by the existent subclinical scorbutic state with its attendant pathologic alteration of the tissues and their metabolism.

2. Similarly, the frequent recurrence of various forms of pyorrhea alveolaris, in spite of vigorous treatment is indicative of the maintenance of a persistent, latent focus of infection, and the presence of tissues which have been so changed by the original infection as to constitute excellent soil for such recrudescence of the disease.

\* From the Marcy Center Dental Clinic, Chicago, Illinois.

In view of this unsatisfactory state of affairs in respect to oral hygienic problems, it is apparent that some new method of treatment is needed in the dentists' therapeutic armamentarium. Such a treatment should be aimed not only at the eradication of the acute, symptomatic phase of infections of the oral cavity, but also designed to aid in the restoration of the tissues to their previous anatomical and normal physiological states. At the same time, perhaps in consultation with the physician, treatment should likewise be directed at any underlying systemic disorder which may co-exist. Recent reports<sup>5</sup> have suggested that in the local treatment of such dental infection, water soluble *chlorophyll* may prove to be just such a desirable biologic agent.

While the precise mode of action of chlorophyll in the human body is not yet entirely understood, a very considerable amount of data has been accumulated during the past few years to explain certain of its effects. It seems obvious that chlorophyll belongs among the relatively essential substances in human economy, for it is one of the important components of our foodstuffs, whether directly in green vegetables or indirectly, in respect to meat derived largely from herbivorous animals. The structure of the chlorophyll molecule has been known for many years since the classical studies of Willstatter<sup>10</sup> and Fischer.<sup>3</sup> Its close relationship to hematin is seen in the essential identity of the pigment portion of the two molecules, with magnesium being substituted for iron and phytol being loosely attached to one of the carbon atoms in place of the globin of hematin. Chlorophyll is, of course, the green coloring of plants which is intimately concerned with plant metabolism, and through a complex photosynthesis in the presence of sunlight, converts carbon dioxide into starch. The relationship of chlorophyll to vitamin A is still obscure although there seems to be a rough parallelism between chlorophyll and carotene content in plants. Thus it can be

seen that chlorophyll is a complex substance which is essential to plant life and also has many ramified connections with human physiology.

The results obtained with water soluble chlorophyll seem to indicate that it exerts a stimulating influence on the fibroblast, thereby producing a new formation of healthy granulation tissue.<sup>6</sup> This is further confirmed by reports of its use both in clinical cases and in the healing of experimentally induced wounds and burns in animals.<sup>8</sup> According to Gruskin<sup>5</sup> the effects of water soluble chlorophyll in healing is twofold: first, prevention of fibrinolysis and second, the encouragement of fibroblastic activity.

We found that the successful result obtained was with the water soluble chlorophyll. It seems that the oil soluble chlorophyll does not produce the desired effect probably due to its impurities or its strongly acid characteristics.

Clinically, chlorophyll has been used by Burgi<sup>1</sup> in the treatment of wounds with very favorable results. He claims that chlorophyll not only stimulates granulation tissue but it also helps in epithelialization. Schweitzer<sup>7</sup> has reported its use in the treatment of anemia by the oral administration of chlorophyll phosphate in tablet form. The possible synthesis of hemoglobin in mammalia from the pyrrole groups derived from the breakdown of chlorophyll has been suggested by Whipple.<sup>9</sup> This has been confirmed by Hughes<sup>4</sup> and Latner by feeding small doses to animals (15 mg.). Gruskin<sup>5</sup> as well as Galatz found chlorophyll useful as an adjunct treatment in advanced carcinoma, noting the prompt disappearance of odors from the ulcerated area. Evidently the action of chlorophyll is on the anaerobic organisms usually present in such conditions.

Experimental studies both *in vitro* and *in vivo* have shown that chlorophyll exerts a moderate bacteriostatic effect upon many of the common organisms pathogenic to man.

As a result of these encouraging reports it was believed that a study of various oral infections treated by water soluble

In pyorrhea the results, so far as the time factor is concerned, have not been perhaps quite as dramatic, but the use of

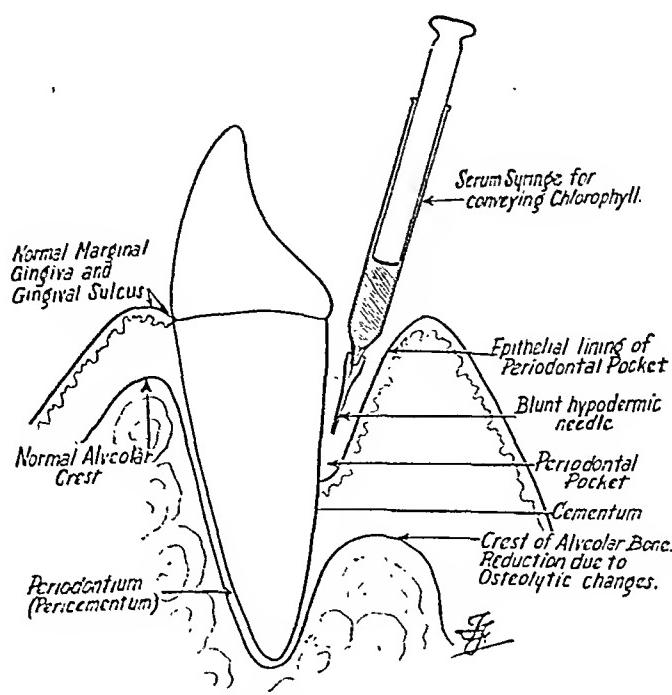


FIG. 1. Illustrating method adopted for conveying chlorophyll. Diagram by Dr. Frederick James, Temple University School of Dentistry, Philadelphia.

chlorophyll might be worth while, especially in cases of Vincent's stomatitis and the several types of chronic periodontal disease, generally classified under the term pyorrhea alveolaris. Accordingly, a series of cases at the Marcy Center Dental Clinic was selected for experimental observation. The early results were so dramatic and satisfactory that the original series was extended and now numbers over 300 cases and the method has been adopted as an almost routine procedure in all cases of Vincent's infection and chronic pyorrhea.

In cases of Vincent's stomatitis we have come to the conclusion that chlorophyll therapy is almost a specific against the fusiform bacillus and spirillum responsible for the condition. As a matter of fact the length of time required to clean up a severe acute Vincent's case has been reduced to a matter of from a few days to a week instead of the usual weeks to months required by our former methods of treatment.

chlorophyll by the technic we have developed has yielded uniformly more satisfactory results than those obtained by any other method of therapy in our hands.

In this connection the absolute lack of toxicity of the drug and its bland soothing effect upon the tissues should be stressed, as being so much in contrast to the usual effective antiseptic agents ordinarily employed in such cases of oral sepsis.

The technic for administering water soluble chlorophyll in Vincent's stomatitis is as follows: (1) Spray mouth with chlorophyll solution around and in between each tooth, at least once daily. (2) When the acute condition subsides careful prophylactic treatment is used.

For treatment at home, the following routine is followed: (1) Water soluble chlorophyll solution is given to the patient to use at home. By means of an eye dropper it is squirted between the teeth three or four times daily. (2) A cathartic is given. (3) A soft diet is prescribed (force fluids);

(4) orange juice is taken; (5) rest is prescribed; (6) old tooth brush is thrown away; (7) no tobacco or alcohol is permitted, and (8) the patient should be

2. After the third administration of chlorophyll, thorough subgingival curettement was started. The use of the Gracey curetts has proved best in our hands.

FIG. 2.



FIG. 3.



FIGS. 2 AND 3. Chronic Vincent's stomatitis and one week after treatment.

isolated. Three or four days has been sufficient to clear up most of our cases.

The technic for administering water soluble chlorophyll in pyorrhea is as follows:

- Pockets in the mouth were flushed with a blunt needle; care was taken so that the chlorophyll reached the extreme depths of the pockets. If this is not accomplished, chlorophyll tends to stimulate granulation tissue formation superficially. Drying the mouth and using a saliva ejector, 5 cc. of chlorophyll, at six to seven minute intervals (totaling 15 cc.) was administered throughout the mouth at each sitting.

- Chlorophyll ointment was packed into pockets and adhesive sheets of tinfoil were placed over area to protect from saliva. The patient was instructed to remove this tinfoil in from four to five hours. In many instances it was kept on overnight.

- Chlorophyll was injected directly into surrounding tissue when found necessary.

- Patients were taught the proper method of brushing and were given chlorophyll solution to use at home in place of the usual dentifrice.

- Treatment was consistent through a period of from four to six weeks.

7. It was found that at least three sittings a week were necessary.

8. Patients were kept under observation by means of monthly recall. An addi-

#### CASE REPORTS

**CASE I.** Vincent's stomatitis. L. G., twenty years of age, appeared on June 10, 1941, complaining of sore mouth and terrible odor. A



FIG. 4.  
FIGS. 4 AND 5. Chronic Vincent's stomatitis and twenty-four hours after first treatment.



tional use of chlorophyll was occasionally indicated.

9. Investigation has proved that a hydrogen ion concentration of 7.2 is desirable for this type of work. (Fig. 1.)

An analysis of the 300 cases treated at the Marcy Center Dental Clinic may

No. of Cases	Diagnosis	No. Patients Cured	No. Patients Improved	Per Cent Cured or Improved
122	Vincent's stomatitis	98	24	80 cured 20 improved
102	Pyorrhea with shallow pockets of 3 mm. or less	81	21	79 cured 21 improved
76	Pyorrhea with deep pockets	21	55	27 cured 73 improved

prove to be of some interest and is presented here in tabular form, listing the number of cases of each type with summary of the clinical results.

clinical and microscopic diagnosis of Vincent's stomatitis was made. The mouth was sprayed with chlorophyll solution around and in between each tooth. Immediately after the first treatment the patient remarked that his mouth felt relieved. The odor disappeared. The usual home treatment substantiated with the use of chlorophyll solution at home was prescribed. The patient was seen four times during the first two days. Scaling was instituted after the third treatment. The patient was dismissed as cured on June 16, 1941, with the usual instruction regarding oral hygiene.

**CASE II.** Pyorrhea. G. V., twenty-nine years of age, came under treatment May 8, 1941. A diagnosis of a chronic suppurative periodonitis was made. The teeth had loosened; there was excessive bleeding of gum tissue on brushing, bad breath, and the patient experienced pain when biting hard, although she had a normal occlusion. Chlorophyll solution and ointment were used along with extensive subgingival curettage. The patient was treated for seven weeks and kept under monthly observation for a year and a half. The odor was gone and the teeth were tight; no bleeding or gingival marginal inflammation were present; the interproximal marginal congestion was relieved and gingival tone was normal.

## DISCUSSION

From these studies of water chlorophyll preparations it would appear we have a new approach to the problems of infection as they relate to the dental field.

In Vincent's stomatitis water soluble chlorophyll has appeared to act almost as a specific, clearing up such infections much more rapidly than by the use of other preparations. Its non-toxic, bland nature needs emphasis, for many of the more standard methods of treatment produce actual tissue damage, thus delaying the healing process. With chlorophyll we again seem to profit by its direct or indirect action on the infecting organisms, especially anaerobic, and by its stimulating effect upon the repair process, promptly improving the tone of the tissues.

In periodontal disease, associated with pyorrhea, gum retraction, loss of interproximal tissue, the loosening of teeth and even osteolytic porotic changes of the alveolar bone, the results have been excellent. Furthermore, the rapidity of the improvement has been phenomenal in a very considerable proportion of the cases. By carefully cleaning out infected periodontal pockets, de-epithelializing them and packing these areas with chlorophyll, as well as directly injecting the chlorophyll into the gums when called for, the result has been the clearing up of the infection, regeneration of bone, the formation of new healthy tissue and resultant tightening of the teeth. With all our emphasis being placed on prophylaxis and the preservation of our teeth, the value of chlorophyll in such a program would not seem to require further comment.

When extraction is necessary, especially when coupled with periapical abscess formation and osteomyelitis of the alveolar bone, again chlorophyll may be used effectively in overcoming the infection and stimulating repair. Sockets appear to heal much more rapidly under chlorophyll packing than by any of the other more usual technics.

## SUMMARY AND CONCLUSIONS

The paper reviews briefly the problems of oral sepsis from the therapeutic standpoint and discusses the rationale of the use of water soluble chlorophyll in this field.

The results of treatment by chlorophyll in a series of 300 cases of Vincent's stomatitis and pyorrhea are reported.

In conclusion we would like to emphasize the following points:

- Water soluble chlorophyll appears to have a definite stimulating effect upon the growth of the supportive connective tissue cells and the development of granulation tissue.

- Odors due to anaerobic infections invariably disappear with a few applications of chlorophyll, probably due to its oxidizing capacity.

- In pyorrhea the use of chlorophyll has resulted in the tightening of teeth, the cessation of bleeding from the gums, and has grown new tissue.

- In Vincent's stomatitis chlorophyll has regularly brought about complete recovery, and much more promptly than with other agents.

Finally, there is no doubt that chlorophyll has a therapeutic place in acute and chronic suppurative diseases of the oral cavity.

Grateful acknowledgment is made to the Rystan Company, New York City, licensees of the Lakeland Foundation, Chicago, for furnishing the chlorophyll solution and ointment used in this series.

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DRIED plasma, because of its long preservation period without undue alterations of the protein constituents, its ease of administration and effectiveness in restoring blood volume, is the blood substitute of choice for use in the Military Services.

From "War Medicine" edited by Winfield Scott Pugh (Philosophical Library, Inc.).

# PLASTIC MATERIALS IN MEDICINE\*

## PRELIMINARY REPORT ON THE USE OF LUCITE AND NYLON FABRIC IN ORTHOPEDIC SURGERY

MICHAEL S. BURMAN, M.D.

Associate Orthopedic Surgeon, Hospital for Joint Diseases

NEW YORK, NEW YORK

LUCITE and nylon are plastic materials which are now well known and used extensively in industry.

Lucite<sup>1</sup> is a polymerized methyl methacrylate. It is light, hard, strong, and is not affected by watery solutions of mineral salts or dilute alkalis. It is well tolerated by the human organism. Its use in medicine is limited to cap arthroplasty, although it should be of some value in the internal splinting of fractures. I have used it in arthroplasty of the interphalangeal joint of a finger (one case), in arthroplasty of the metacarpophalangeal joint (two cases) and in arthroplasty of the hip (one case). The first case—that of the interphalangeal joint arthroplasty—was done on August 6, 1940. The operative wounds healed well and the lucite cups have all been well tolerated. The result of operation is fair to good as regards joint motion. Lucite has been tried experimentally to fill in articular defects in cartilage.

Harmon<sup>2</sup> reported on the use of lucite caps in hip arthroplasty, my use of the lucite being independent of his work and suggested by Dr. Robert Abrahamson.

Nylon is the generic name for all synthetic fiber-forming polymeric amides having a protein-like chemical structure.<sup>3</sup> It is physiologically inert, except for rare instances of allergy. It is used as a surgical suture material.<sup>4</sup> Its inertness suggested its use as an interposition material in arthroplasty, particularly of small joints, as a fascial band as in the fascial plastic for paralysis of the abdominal musculature, and as an artificial tendon sheath. A fine meshed fabric should be used.

Serous fluid collects about a strip of implanted nylon, indicating some measure of foreign body irritation. Yet this ability to form fluid is of value in arthroplasty, since such fluid may act as a synovial fluid. Its use as a fascial-like transplant in paralysis of the abdominal wall was tried unilaterally, in conjunction with a strip of fascia, on May 11, 1942, after its experimental implantation into the thigh at the time of the first fascial graft on April 13, 1942. A large amount of serosanguineous fluid collected about this large strip (6 inches by 2 inches) of nylon fabric. Parachute nylon fabric has been used twice in arthroplasty of small joints. Nylon arthroplasty of the carpometacarpal joint of the thumb done on June 8, 1942 gave an excellent functional result. A second case—arthroplasty of an interphalangeal joint—was done on October 19, 1942. The use of nylon as an artificial tendon sheath of a finger flexor tendon (March 21, 1942) failed because a rough, coarse-meshed nylon (stocking nylon) was used.

Further study may indicate the possible value of these plastics for the uses indicated. Their cheapness, their relative inertness, and their radiolucency make for certain advantages over vitallium.<sup>5</sup>

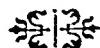
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\* From The Hospital for Joint Diseases, Services of Dr. Harry D. Sonnenschein and Dr. Leo Mayer.

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I am indebted to the Huguet Corporation for the nylon fabric.



IN pronounced cases the most striking factor which confronts one when he approaches cardiotoxic patients is that they are prematurely old. The far-away, weary look in many patients is striking, and pitiable. The features exude weariness; the skin is bronzed, and one can almost see its inelasticity. In more advanced cases dyspnea and edema are added to the picture.

From "Diseases of the Thyroid Gland. Presenting the Experience of More Than Forty Years" by Arthur E. Hertzler (Paul B. Hoeber, Inc.).

# Case Reports

## PRIMARY CARCINOMA OF THE URETER\*

SAMUEL A. JAFFE, M.D. AND

Assistant Attending Surgeon, Grace Hospital

ANTHONY J. MENDILLO, M.D.

Consulting Surgeon, Grace Hospital

NEW HAVEN, CONNECTICUT

THE ureter is recognized as one of the rarest locations for primary malignancy. Only during the past decade have enough cases been accumulated to draw statistical conclusions of this condition. The large number of case reports in recent years, two-thirds of all the reported cases appearing in the literature during the past ten years, suggests that primary carcinoma of the ureter is being recognized more frequently due to modern development and refinement of urologic technic. However, data of large medical centers still label this lesion as a rarity. The Brady Urological Institute encountered three cases, from a series of 22,000 urological admissions;<sup>1</sup> Bellevue Hospital reports one case from a series of 22,810 necropsies.<sup>2</sup> The University of Minnesota found only one case in a series of 37,000 autopsies.<sup>3</sup> In a series of 16,565 malignant tumors encountered at the Memorial Hospital, Pack and Le Fevre apparently did not find any primary ureteral malignant growths.<sup>4</sup> During the past ten years, 1933 to 1943, at Grace Hospital in New Haven, two cases have been encountered in a series of about 90,000 routine admissions of all types. Nineteen hundred of these patients were found to have primary malignancies in various locations, the above two cases being the only ones originating in the ureter.<sup>5</sup>

### HISTORY

Rayer,<sup>6</sup> in 1841, is considered by many to have reported the first case of primary

carcinoma of the ureter. The tumor was discovered at autopsy and the diagnosis was based on gross rather than microscopic examination. Wising and Blix<sup>7</sup> are credited by the others for the first reported authentic case, for in 1878, they reported the first case complete with microscopic diagnosis. It was not until 1884, that Davy<sup>8</sup> recorded the first case in the English Literature. Eight cases in all were reported by 1900, the diagnoses being made at autopsy. The first correct pre-operative diagnosis was made in 1902 by Albarran.<sup>9</sup> In 1924, Kretschmer,<sup>10</sup> in reviewing the literature, collected thirty-four case reports and added one of his own. In 1934, Scott<sup>11</sup> and Lazarus<sup>12</sup> each presented a study of the sixty-eight cases reported until then. In 1936, Schillings and Sondervorst<sup>13</sup> made a thorough study of the literature and collected 113 records, but Higgins,<sup>14</sup> in 1938, would only accept eighty-six of the published cases as being definitely established primary carcinoma of the ureter and added five of his own cases. Foord and Ferrier,<sup>15</sup> in 1939, reported six additional cases and collected 133 from the literature. Stang and Hertzog,<sup>16</sup> in 1941, reported four cases, and Cook and Counseller,<sup>17</sup> also in 1941, reported eighteen cases from the Mayo Clinic. Five other cases were recorded in 1940<sup>18,19</sup> and 1941.<sup>20,21</sup> T. Moore,<sup>22</sup> in April, 1942, in his paper "Tumors of the Ureter" wrote that there are well over 150 reported cases of primary carcinoma of the ureter and recorded one new case.

\* From the Surgical Service of Grace Hospital, New Haven, Connecticut.

Riches,<sup>13</sup> in April, 1942, reported another case. Five more cases were added during the latter part of 1942 by McCrea,<sup>24</sup> Scholl and Gallagher,<sup>25</sup> Daniel,<sup>26</sup> and Sauer.<sup>27</sup>

In our review of the literature, we have been able to find 173 case reports; with our own two cases herein recorded, the total number of reported cases of primary carcinoma of the ureter is brought up to 175.

#### PATHOLOGY

Although the ureteral epithelium is of mesodermal origin and the bladder epithelium is of entodermal origin, there is no demarcation between these membranes in the adult, since both produce the same sort of transitional epithelium in these regions. Consequently, ureteral neoplasms are apt to simulate very closely the bladder tumors both in microscopic appearance as well as in the clinical course of the disease. However, the larger percentage of cases showing metastases at operation or autopsy, and the poorer end results suggest that ureteral neoplasms possess a higher degree of malignancy than do bladder tumors; of course, a later diagnosis may also be a factor in the poorer end results.

The ureteral neoplasms may be divided into papillary and non-papillary types. In some cases, gland formation has been seen microscopically; to these, the term adenocarcinoma has been attached. Foord and Ferrier,<sup>15</sup> in analyzing 139 cases, stated that seventy-five were papillary, sixty non-papillary, three were adenocarcinoma, and one was unclassified. They say that it is important to recognize that infiltration of the ureteral wall occurs in all the three types.

The neoplasm may affect one or several parts of the ureter, may be small or extensive, and may or may not encircle the lumen of the ureter. Spread tends to occur to the surrounding tissues, to regional lymph nodes, and by the blood stream to any part of the body; the liver and lungs particularly appear to be involved. A case has been reported in which the brain was

explored for a tumor which proved to be a metastasis from a primary neoplasm of the ureter (Hunt 1927).<sup>28</sup>



FIG. 1. Excretory urogram. Definite pyelectasis, caliectasis, and ureterectasis may be seen on the left side.

Although any part of the ureter may be involved, in about 75 per cent of the reported cases, the primary growth occurred in the lower one-third of the ureter. In many cases (33½ per cent) on cystoscopic examination, the tumor has been seen protruding into the bladder through the ureteral orifice. Both ureters seem about equally involved.

Complicating pathologic processes are common in this affliction, the usual one being hydronephrosis; this is but a natural sequel to ureteral obstruction with dilatation above it. Secondary infection commonly follows, the symptoms of which often first bring the patient to the physician. Associated calculi are found in 10 to 20 per cent of the cases.

#### CAUSATIVE FACTORS

The exact cause of primary malignancy here is no better understood than in other parts of the body. Many writers have

stated that calculi with resultant chronic irritation is an important causative factor. However, this does not appear to be so,



FIG. 2. Ureteral catheter in pelvis of kidney on the right side. Left ureteral catheter meets an impassable obstruction.

otherwise, primary carcinoma of the ureter should be seen much more frequently because of the great incidence of urinary calculi; also, in many of the reported cases, the calculi were present on the opposite side. It is more probable that the calculi found associated with the malignancies (10 to 20 per cent) are incidental or that the calculi are secondary to the urinary stasis produced by the growth.

T. Moore<sup>22</sup> states that certain dyes of the aniline series are closely related to the onset of bladder neoplasms in people engaged in this industry. The same may be true in ureteral neoplasms. Muller,<sup>19</sup> in 1940, reported a case apparently caused by benzidine. Arsenic may also be a causative agent according to Goeckerman and Wilhclm.<sup>23</sup>

#### CLINICAL FEATURES

**Age.** The greatest incidence of this disease occurs in the age group from the

fourth to the eighth decades. The average age is fifty-five. The youngest patient was twenty-two, and the oldest patient was eighty-nine.

**Sex.** A review of the reported cases indicate no significant preponderance of one sex over the other.

**Symptoms.** The classic triad consists of: (1) hematuria, (2) pain, and (3) tumor. Hematuria is the most frequent and the earliest symptom. It appeared in about 75 per cent of the reported cases and the duration of the bleeding varied from weeks to several years. The urine is often grossly bloody, especially in the larger papillary tumors, or may be seen to contain blood only on microscopic examination, as in the non-papillary small growths. The onset of bleeding is usually sudden, without any immediate apparent cause, and tends to be intermittent.

Pain is next in frequency and may be of one or any combination of the following three types: (1) ureteral colicky pain, caused by ureteral obstruction or by the passing of blood clots down the ureter; (2) renal aching pain, dull aching pain in the kidney region and in the flank due to ureteral or pelvic distention; and (3) referred pain, due to involvement of neighboring tissues. Pain of varying degree and type is present in about 75 per cent of the cases and its duration, in the reported cases, varied from several weeks to several years.

The tumor palpated is usually a mass in the loin which is the enlarged hydro-nephrotic kidney secondary to the ureteral obstruction. Seldom does the ureteral neoplasm itself produce a palpable tumor. However, several cases have been reported in which the primary growth was palpated. In these cases the malignancy occurred in the lower one-third of the ureter.

#### DIAGNOSIS

As with other diseases, a good history and physical examination is essential. Along with these, urinalysis, cystoscopy,

and urography, both excretory and retrograde, are of utmost importance in the diagnosis of ureteral neoplasm.

In the urine, red blood cells are undoubtedly present at some time. Pus is generally present due to the secondary infection. Occasionally, cancer cells or even fragments of the tumor may be seen in the urine, especially if the neoplasm is of the papillary type, and always when the growth projects into the bladder.

Cystoscopic examination may show a bloody spurt from the affected ureter; or if obstruction from the growth is complete, no urine appears from the ureteral orifice. In about one-third of the cases, a tumor may be seen projecting through the ureteral orifice. In cases in which no abnormalities are seen, a catheter passed up the ureter will often result in bright red blood emerging from the orifice alongside the catheter and through the catheter. If the catheter can be passed up beyond the tumor, the catheter drainage will then again tend to be clear or turbid and not bloody. This has been considered by many to be a pathognomonic sign. In 50 per cent of the cases there is complete obstruction and the passage of a catheter or bougie is not possible. The appearance time and concentration of indigo carmine depends upon the degree of obstruction.

An open abdominal film often shows an enlarged kidney shadow due to the associated hydronephrosis. Coincidental calculi may also be seen.

Excretory uograms are of limited value in demonstrating either a filling defect or the stricture in the ureter. They usually demonstrate only the degree of function remaining in the kidney. If function is present, the degree of hydronephrosis and hydroureter may be visualized.

Retrograde pyelo-ureterography is the procedure of choice to show the actual lesion and its position. A catheter must be passed, or at least its tip engaged, in the ureteral orifice so that the ureter may be filled sufficiently to show the defect. It is also very important to note whether the

filling defect is constant, and thereby avoid error from a filling defect due to a blood clot or a non-opaque stone. Serial



FIG. 3. Retrograde urogram of an opaque catheter in the left ureter. Obstruction is at the level of the second sacral segment.

pyelograms as advised and demonstrated by Moore<sup>30</sup> are useful in the determination of a constant filling defect. The filling defect may take several forms: (1) a ring-like obstruction, (2) an ovoid defect, large or small, (3) a moth-eaten appearance, due to extensive involvement by a papillary type of neoplasm, or (4) several defects, due to many implantations.

Aside from these positive evidences, it is also important to remember that a bleeding ureteral neoplasm may be so small that it will not cause ureteral obstruction, will not show a filling defect, will not show hydronephrosis, and will not reveal a palpable mass upon surgical exposure. If a nephrectomy has been performed, and the kidney does not explain the source of bleeding, or if there is persistent hematuria after the nephrectomy, prompt ureterectomy should be performed.

It is also of utmost importance, that in all cases of hydronephrosis, especially in patients over fifty years of age, the



FIG. 4. Gross specimen showing kidney and ureter attached. Two large masses are seen filling the lower portion of the ureter. No growths are present in the kidney or the pelvis.

causative factor should be definitely ascertained. Repeated cystoscopy with ureterography may bring to light an early neoplasm of the ureter.

#### TREATMENT

A number of different surgical procedures have been suggested and attempted in the treatment of neoplasms of the ureter, e.g., canterization, fulguration, partial resection of the ureter with reimplantation of the ureter into the bladder, partial resection of the ureter with ureterostomy, and nephro-ureterectomy. Undoubtedly, the best procedure at present is a total nephro-ureterectomy with removal of a cuff of bladder and removal of the perirenal and peri-ureteral fat. This procedure may be done in one or two stages, depending upon the condition of the patient and the experience of the surgeon. There are many advocates of the two-stage operation. Foord and Ferrier<sup>15</sup> have shown that the mortality rate was 40 per cent in one-stage operations as compared with 5 per cent mortality in the two-stage operation. It seems to us that the one-stage procedure is the better one. The mortality rate of the one-stage operation should be markedly decreased in the future because of better preoperative and postoperative care, better and safer anesthesia, and more

experience and improvement in the technic of this procedure.

Preoperative and postoperative irradiation also are worthwhile. Hess<sup>16</sup> has advised the use of radium preoperatively, and has constructed an apparatus and devised a method whereby the radium may be applied directly to the lesion in the ureter. Postoperative irradiation is important to help prevent local and bladder recurrences and also to relieve the pain of extension and metastases.

#### PROGNOSIS

In the past, the prognosis has been poor. The majority of those who survived the operation were dead within a period of two years due to local recurrences and metastases. Scott,<sup>17</sup> in 1934, in an effort to follow collected cases in which operation was performed, found only two patients alive after five years. Krasft<sup>18</sup> reported a case of a patient who was well eleven years after a nephro-ureterectomy for a papillary epithelioma of the lower part of the ureter. Four eight-year cures have been reported, the latest by Cook and Connellor.<sup>19</sup> The prognosis in the future should be more bright with early diagnosis, early and adequate surgery and with proper irradiation.

#### CASE REPORTS

**CASE 1.** A sixty-five year old married housewife, born in Finland, entered Grace Hospital with the chief complaint of pain originating in the left side of her back and radiating to the left flank and down to the left lower quadrant of the abdomen. The pain had begun six days prior to hospital admission and had persisted throughout the six days. There was associated nausea but no vomiting. There were no urinary complaints of hematuria, dysuria, urgency or frequency. She had no previous episodes of a similar nature. A review of the other systems revealed no abnormalities; there was no history of weight loss. Her menses had stopped ten years before admission. She had no previous serious illnesses or injuries; her only operation was a cholecystectomy fifteen years prior to this hospital admission. Family history revealed that her mother died of "cancer of the stomach."

The patient was a well developed, well nourished, white female, appearing about sixty years of age, in no acute distress. A complete examination revealed nothing remarkable except for abdominal findings of an indefinite mass in the left flank which was moderately tender to palpation. There was no abdominal spasm or rigidity and no other masses were palpable. On admission her temperature was 100.4° F., pulse was 100, respirations 20, and her blood pressure was 140. 85.

The red blood count was 4.01 million with eighty-six per cent hemoglobin by the Dare method; the white blood count was 7,000 with sixty-eight per cent polymorphonuclear cells, 2 per cent of which were non-segmented. A catheterized urine specimen was slightly cloudy, acid in reaction, specific gravity of 1.012, contained 2 plus albumen, 0 sugar, and no casts; microscopically many red blood cells and white cells were seen. Blood non-protein nitrogen was 28; Blood Wassermann and Kahn tests were negative. Repeated urines continued to show many red blood cells and white blood cells.

On the day following admission to the hospital, an open abdominal x-ray film was taken. This was reported as showing "considerable gas in the colon; there seems to be a poorly defined soft tissue mass in the left mid-abdomen which probably is associated with the kidney." On the next day intravenous pyelography was done. This revealed a left hydronephrosis with hydro-ureter due to obstruction of the lower portion of the left ureter. (Fig. 1.) On the fourth hospital day, cystoscopy with retrograde urography was performed by Dr. H. Levin. On the right side no difficulties were encountered, but on the left side an impassable obstruction was met 10 cm. up the ureter. Attempts to promote flow from the left side met with failure; 5 cc. of indigo carmine were injected intravenously as a function test; normal excretion and concentration was seen on the right side but from the left side no dye was obtained throughout the course of the examination. Injection of 12 per cent Skiodan into the left ureteral catheter was then done and x-rays were taken; these revealed a defect in the left ureter at the level of the tip of the catheter which lay just below the sacral promontory. Slight dilatation of the ureter distal to this point

was seen as well as a lack of filling of the ureter proximal to the defect. (Figs. 2 and 3.)

The patient was taken to the operating room



FIG. 5. Gross specimen of the ureter. The large primary neoplasm may be seen in the lower portion of the ureter. Several secondary implants may also be seen.

with a preoperative diagnosis of left hydronephrosis with complete obstruction of the left ureter, probably due to a primary neoplasm of the left ureter. Anesthesia was induced by spinal injection of pontocaine-glucose solution. Exploration through a left lateral oblique lumbar incision revealed the presence of a hard intra-ureteral mass approximately 8 cm. from the ureteral entrance into the bladder. Because of the probability of this mass being a malignancy of the ureter, a nephro-ureterectomy with the removal of a cuff of bladder was performed. Most of the perirenal and periureteral fat also was excised. The patient withstood the procedure well and was returned to her room in good condition. Her postoperative course was uneventful and she was discharged from the hospital on the fourteenth postoperative day. The patient has been seen at intervals

during the past one and one-half years. She has had no complaints and appears in good health.

the surrounding fat tissue. It appeared to be of a medium grade of malignancy—Grade 2—according to Broder's classification. (Fig. 6.)



FIG. 6. Microscopic section.  $\times 20$ . On the right side may be seen the normal architecture of the ureter. On the left side the ureteral wall reveals nests of poorly staining and poorly differentiated squamous cells invading widely.

Pathologic examination was done by Dr. C. J. Bartlett. The specimen consisted of a kidney with ureter attached. The ureter showed several whitish growths on the inner surface, some of which were elevated. The largest growth measured 2 cm. vertically; the smallest measured 5 mm. The upper 4 or 5 cm. of the ureter showed nothing suggesting a tumor growth and nothing was seen in the pelvis of the kidney suggesting one. The kidney was somewhat enlarged and there was moderate dilatation of the pelvis and calyces. Nothing resembling a tumor growth was found in the kidney. (Figs. 4 and 5.) Microscopic examination of the largest growth which was lowest in the ureter revealed a squamous cell carcinoma. It had invaded the wall to a considerable extent and one group of tumor cells was found in the very outer part of the wall adjacent to

CASE II. A forty-seven year old Irish male entered New Haven Hospital June 23, 1938, because of painless hematuria of two weeks' duration. He presented no other symptoms. A review of his symptoms was normal. There were no contributing factors in the patient's past history or family history.

The patient was a well developed, fairly well nourished white male in no acute distress. Examination was negative throughout. The abdomen revealed no masses or palpable viscera; there was no tenderness or spasm. Vital signs were essentially normal.

The red blood count was 4.1 million with 84 per cent hemoglobin. The white blood count was 12,000 with 76 per cent polymorphonuclear cells. The urines were grossly bloody and showed 3 plus albumen. Blood Wassermann test was negative.

Cystoscopy with retrograde urography was performed. This revealed a left renal calculus, hydronephrosis and hydro-ureter, and a non-opaque obstruction in the ureter just above the bladder. The patient was taken to the operating room, where, upon exploration, the obstructing mass in the ureter was felt. Because of the possibility of this being a primary malignancy of the ureter a typical nephroureterectomy was done. His postoperative course was uneventful.

Pathologic examination of the specimen revealed a papillary squamous cell carcinoma of the lower ureter with hydronephrosis and hydro-ureter.

On May 20, 1939, the patient was admitted to Grace Hospital in an irrational condition. At this time, a tender, stony-hard mass was found filling most of the left side of the abdomen. X-rays revealed a soft tissue mass in the left lower quadrant and metastatic lesions of the sacrum. His course was progressively downhill and he expired May 28, 1939, about one year after the onset of symptoms.

#### SUMMARY AND CONCLUSIONS

- Primary carcinoma of the ureter is a comparatively rare disease. The literature is herein reviewed.

- Two cases are reported, bringing the total number of reported cases to 175.

- Earlier recognition is assured by modern refinement of urologic technic.

- The prognosis is vastly improved because of earlier diagnosis, earlier and more adequate surgery, and proper irradiation.

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# PSEUDOMYXOMA PERITONEI

A. HINSON, M.D.

Attending Surgeon, York County Hospital;  
Now Chief of Surgical Service Station Hospital, Will Rogers Field, Okla.  
ROCK HILL, SOUTH CAROLINA

DEAVIER<sup>1</sup> quotes Werth, Fraenkel and Neugebauer's description of multiple pseudocyst formation in which multiple gelatinous globules have studded the appendix and even the surrounding visceral serosa.

Since then occasional reports have appeared in the literature on pseudomyxoma peritonei. The greater majority of the cases reported have arisen from perforations of pseudomucinous cystadenomas of the ovaries. A small percentage result from perforations of mucoceles of the appendix.

Weaver<sup>2</sup> reported 256 cases of mucocele of the appendix in 1937 with forty-nine cases of pseudomyxoma peritonei. Thirty-five of these were in the female, fourteen in the male. Among theories that have been advanced the most likely is that of continued or repeated attacks of inflammation eventuating in stenosis of the base with continued secretion of mucus.

Grodinsky and Rubnitz<sup>3</sup> experimentally produced mucoceles in rabbits.

The increased intra-appendiceal pressure produces weakness and thinning of the wall, separation of muscle bundles, herniation of the mucosa and eventually rupture with widespread dissemination in the peritoneal cavity. Probably the occurrence of pseudomyxoma peritonei with papillary implants depends on the ability of the cells to grow and secrete after transplantation.

The secreted pseudomucin is only partially absorbed due to its rapid formation. Papillary growths enter this material using it as a framework resulting in a mixing of the two elements.

Grossly pseudomyxoma peritonei is easily recognized in the advanced cases. In

some of the earlier cases it may be missed unless we are cognizant of the possibility of its appearance. The mucocele must rupture before pseudomyxoma peritonei can be formed. At times a small rupture may heal leaving the mucocele apparently intact. This may be repeated on many occasions. Usually the proximal lumen is closed but occasionally it is open, probably resulting from increased intraluminal pressure.

The gelatinous material has a "frog spawn" or "fish egg" appearance in clear or cloudy fluid. Usually it is only in the right lower quadrant but occasionally it is found throughout the abdomen as in my case reported below. The gelatinous material takes an acid stain and shows strands of columnar epithelial cells scattered throughout and showing a tendency to form cysts.

Chassie and LeGrand<sup>4</sup> give an excellent comparison of the appendiceal with the ovarian origin of this condition: Pseudomyxoma peritonei originates in a mucocele of the appendix. It causes a mechanical obstruction of the lumen and rupture of a mucocele. The clinical course is more benign but the prognosis is better. The histologic nature of the implants shows malignancy in 38 per cent; is not so cellular and contains chains of single cells. Gross characteristics show a single mucocel. The reaction of the exudate is acid.

Pseudomyxoma peritonei originating in ovarian cystadenoma is a neoplasm caused by a rupture of the cyst. It is more malignant, and the prognosis is poor. In 43 per cent it is malignant. It is more cellular and alveolar and papillomatous tendencies are present in many. Bilateral ovarian tumors occur in 50 per cent and bilateral involvement in 73 per cent of the cases in which

the process was malignant. The reaction is alkaline.

That many cases of pseudomyxoma

obstructive symptoms due to the irritative chronic agglutinous peritonitis should cause one to suspect the possibility of its pres-

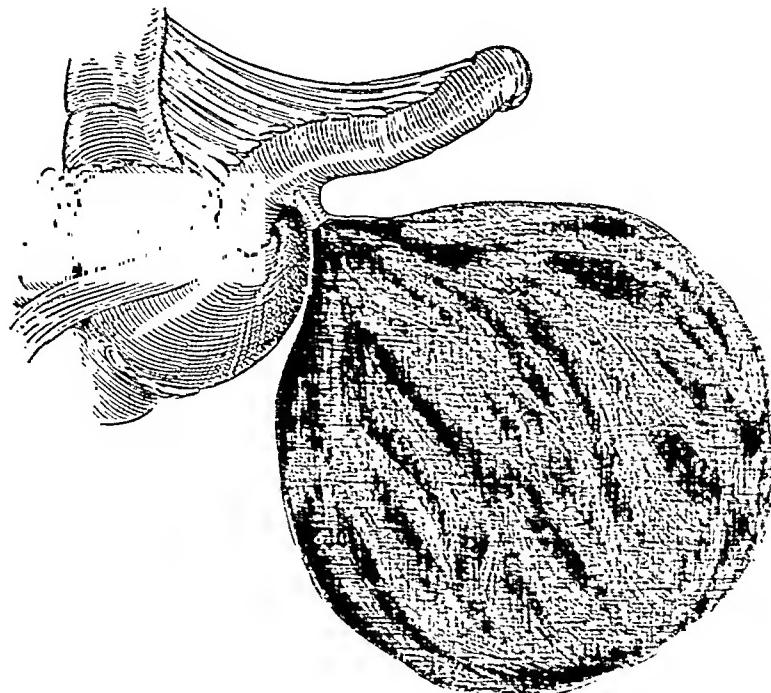


FIG. 1. Diagram showing relative position of appendix, cecum and tumor.

peritonei are malignant is shown by their subsequent course. This tendency to malignant degeneration is quite noticeable when of ovarian origin. Novak<sup>5</sup> states that even in small frankly benign ovarian papillary pseudomucinous cystadenomas there is no certainty of a benign clinical course. The impossibility of evacuating all of the pseudomyxomatous material at operation is obvious. In the cases collected by Jefferies,<sup>6</sup> in 1932, 38 per cent were considered malignant. Apparently the malignant tendency remains local in most cases arising from mucocele of the appendix as no lymphatic involvement has been shown.

The preoperative diagnosis has never been made except in three instances by peritoneoscopy. There is no exact clinical picture. The symptoms are vague with pain being predominant. It is usually of long standing and intermittent in character. The gradual increase in size of the abdomen, vague discomfort and later

ence. Loss of weight, anorexia and vomiting may be present but these symptoms are usually due to secondary changes.

I was able to diagnose one case of mucocele of the appendix preoperatively by the presence of a sausage-shaped mass in the right lower quadrant with symptoms of acute appendicitis in a thin individual. No rupture was found at operation nor was there any evidence of pseudomyxoma peritonei.

Death usually ensues in two to three years due to reaccumulation of fluid and exhaustion, obstruction or malignant degeneration.

The treatment should consist of appendectomy with removal of all of the gelatinous material possible. In some early cases this has apparently resulted in cures. It is only too often that the end is preceded by repeated bouts of intestinal obstruction. In many cases treatment of the obstruction may give several years of

fairly useful life. Irradiation has been used but to date the results have been poor.

#### CASE REPORT

Mrs. J. W. H., age fifty-one, a white housewife, was admitted to the York County Hospital August 4, 1941, with a diagnosis of arrested pulmonary tuberculosis bilateral and subacute appendicitis.

The patient had pain and tenderness in the right lower quadrant for eight years at irregular intervals; she was usually nauseated and vomited with attacks. She had severe constipation and there was gradual enlargement of the abdomen for the past several years. The present attack began three weeks before admission with pain in the right lower quadrant, nausea, vomiting and constipation relieved with enemas.

Physical examination revealed an obese white woman apparently resting comfortably. Her blood pressure was 170/116; temperature 99°F., pulse 80 per min. There was dullness of both apices with most râles down to the third interspace on the right. There was tenderness with slight muscle spasm in the right lower quadrant and slight rebound tenderness. No masses were palpated. She had chronic cervicitis with moderate rectocele; the uterus could not be palpated; the right adnexal region was tender but no masses were palpated.

Hemoglobin was 84 per cent; leucocytes 9,200; polymorphonuclears 80 per cent; lymphocytes 15 per cent; monocysts 5 per cent.

Because of the long history a barium enema was administered. The only positive finding was a fixation of the tip of the cecum; there were no filling defects.

On August 5, 1941, the abdomen was explored through a low right rectus incision under spinal anesthesia. The entire abdominal cavity was filled with a whitish, gelatinous mass about the consistency of tomato aspic. There was slight agglutination of gut which was everywhere thickened and reddened. Scattered over the peritoneal surface were many streaks and papillary projections of a firmer tissue. Over one gallon of this gelatinous material was evacuated before it was found to be coming from a mass in the right lower quadrant which was firmly attached to the end of the cecum and abdominal wall in the iliac region. The

omentum was adherent and after its removal an orange-size friable tumor was seen to arise from the central portion of the appendix. The appendix was four inches long and one inch in diameter, being distended with a continuation of the growth through an opening in its central portion about one-half inch in diameter. The tumor and appendix were dissected free with difficulty from the surrounding structures. Much of the tumor had to be removed by morcellation. It was semigelatinous in consistency but much firmer than the surrounding gelatinous material found throughout the entire peritoneal cavity. The pelvic structures were atrophic and were entirely free from the primary growth. They were the seat of many secondary transplants, however.

The appendiceal stump was ligated and inverted. The abdomen was closed in the usual manner. The postoperative diagnosis was pseudomyxoma peritonei from a mucocele of the appendix. The postoperative course was uneventful and she was discharged thirteen days later.

The pathological report by Dr. Kenneth M. Lynch of Charleston, S. C. was as follows:

"Received a stubby appendix showing a nodular deformity proximally, apparently of mucinous character protruding on the serosal surface. The lumen contains similar appearing material. Also ragged bits of translucent gray material with nodules of light yellow colored tissue attached.

"Sections of appendix show distention of lumen by mucinous material with large actively secreting mucous cells in the appendiceal glands. There is eversion of the mucosa with extrusion through a rent in the appendiceal wall so that the mucosa spreads out over the serosal coat. The bits of translucent grey material consists of mucinous material showing some organization. Much of this is attached to fibro-fatty tissue which also shows fibroblastic activity and inflammatory infiltration.

Scattered throughout the mucinous material are strands of columnar cells with a slight stroma showing a tendency to cyst formation.

"Pathological Diagnosis: Mucocele of appendix, ruptured, with pseudomyxoma peritonei."

Since leaving the hospital she has had a flare-up of the pulmonary lesion. She

is now in a sanitorium for this condition. The abdomen is quiescent except for persistent constipation. The usual course of this disease leads us to expect trouble within the next two years.

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CONSTIPATION is so usual in the early stages of acute appendicitis that when diarrhoea accompanies it the true diagnosis is liable to be overlooked. If diarrhoea is accompanied by even slight, but constant, tenderness and some rigidity in the right iliac fossa, other things being equal, the appendix should be explored.

From "A Short Practice of Surgery" by Hamilton Bailey and R. J. McNeill Love (H. K. Lewis & Co. Ltd.).

# CARCINOMA OF THE TIP OF THE TONGUE

## A CASE OF METASTASIS FROM A MALIGNANT TUMOR OF THE BREAST

IRA FINK, M.D.\*

Associate Visiting Surgeon, Harlem Hospital

AND

JOHN GARB, M.D.

Diplomate of the American Board of  
Dermatology and Syphilology

NEW YORK, NEW YORK

We are reporting an unusual case of carcinoma of the tip of the tongue metastatic from a primary malignant tumor of the breast.

### CASE REPORT

Mrs. E. G., forty-one years of age, a housewife, came to one of us (J. G.) on March 8, 1942, complaining of a growth on the tongue of six weeks' duration. In July, 1940, she had a radical operation for cancer of the right breast followed by a course of deep x-ray treatments. In January, 1942, during the second course of x-ray treatments she began to feel a soreness at the tip of the tongue followed by a little nodule which grew rapidly and became "ulcerated." The family history was negative. She was married fifteen years but never became pregnant. Her menstrual periods had been regular and normal and not accompanied by dysmenorrhea. The tonsils were removed at twenty and a submucous resection of the nose was performed at thirty years of age. She gave a history of frequent attacks of acute sinusitis and frontal headaches.

The growth was oblong, 1.5 cm. in length, 1 cm. in width at the distal end, narrowed at the base to 0.5 cm. The sides were smooth and covered by mucous membrane of the tongue but the distal end was denuded of superficial epithelium, rough, irregular, rounded, cauliflower-like and friable. It appeared as if the growth was set in the tip of the tongue for a distance of 2 to 3 mm. and held *in situ* tightly by the lateral margins of the tongue, contracting it. The rest of the tongue appeared normal, freely movable. The floor of the mouth, the pharynx and tonsillar fossae were likewise normal in appearance. The teeth were in fair condition. There were no enlarged glands palpable in the submental, submaxillary and

supraclavicular regions. The thyroid was not enlarged.

The patient was 5 feet 2 inches (148 cm.) in height and weighed 120 pounds (54.5 Kg.). She appeared in fair physical health, though worried and apprehensive. The pupils were moderately dilated, regular and reacted well to light and accommodation. The sclera were clear. The mucous membrane of the nose was injected. No sinus or mastoid tenderness was elicited. There was a scar at the area of the amputated right breast. There were no palpable nodules in and around the scar and in the other breast. The breath sounds were vesicular but diminished on the left lower chest. Râles were not heard. The apex beat was in the fifth interspace in the midclavicular line. The heart sounds were of good tone. There were no murmurs audible. The liver was not enlarged. The abdomen did not reveal any tenderness, rigidity or palpable masses. The knee and ankle jerks were normal. There was no edema of the ankles. The genitourinary system seemed normal.

The Wassermann and Kahn reaction were normal. The hemogram showed 3,300,000 erythrocytes, 71 per cent hemoglobin, 9,400 leukocytes, 81 per cent neutrophiles, 12 per cent lymphocytes, 5 per cent monocytes, and 2 per cent stab cells. Several urine examinations showed a slight trace of albumen and a few epithelial and white blood cells.

A roentgenogram of the chest (Fig. 1) read by Dr. Charles Gottlieb showed "diminished illumination of the entire left pulmonary field. The right pulmonary field is slightly hyper-illuminated, as the breast was removed on this side. There is one rounded area of diminished illumination in the upper and inner portion of the left pulmonary field. This is about 2 cm. in diameter and is due to metastasis."

The patient was admitted to the Medical Center of Jersey City on July 22, 1940. A

\* Dr. Fink is now a Major in the Medical Corps of the U. S. Army.

radical right mastectomy was performed. She was discharged on August 4, 1940. The following are the reports as given by the Medical Center:

white, elastic, with scattered small cysts and fatty tissue. There are no lymph nodes in the axillary fat."

*Histologic Report.* (Figs. 2 and 3.) "Sections

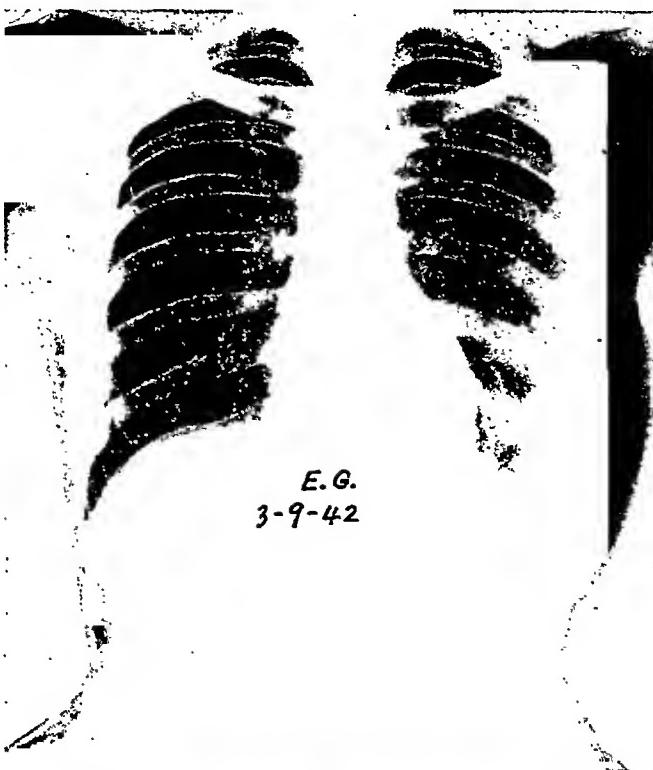


FIG. 1. Showing diminished illumination of the entire left pulmonary field.

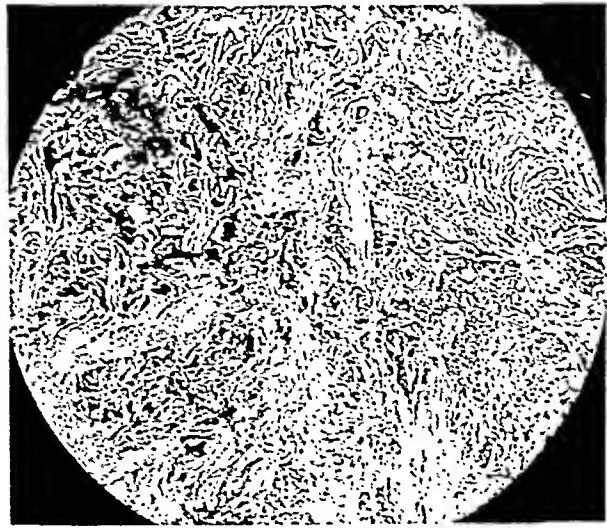


FIG. 2. Photomicrograph of the tumor of the breast, low power magnification.

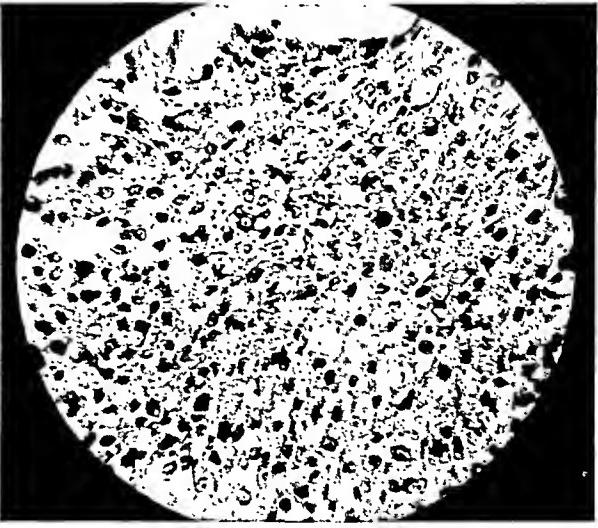


FIG. 3. High power magnification of the tumor of the breast showing masses of polyhedral cells, centrally placed nuclei, conspicuous nucleoli with mitotic figures.

*Gross Examination.* "The specimen consists of a breast received in formalin and measuring  $25 \times 17 \times 6$  cm. The skin is smooth and in the lower portion there is a healing incision with drainage tubes. The cut surface is firm,

show masses of closely related polyhedral cells, centrally placed nuclei and conspicuous nucleoli. Mitotic figures are frequently seen. There is a desmoplastic reaction. In the adjacent tissue adenomatous hyperplasia of the glands, intra-

ductal proliferation of the epithelium, and sclerosing adenomatous hyperplasia are noted." Hospital under avertin and intratracheal anesthesia. Stay sutures were inserted on both sides of the tip of the tongue. The pharynx

**Diagnosis.** "Infiltrating duct cell carcinoma



FIG. 4.

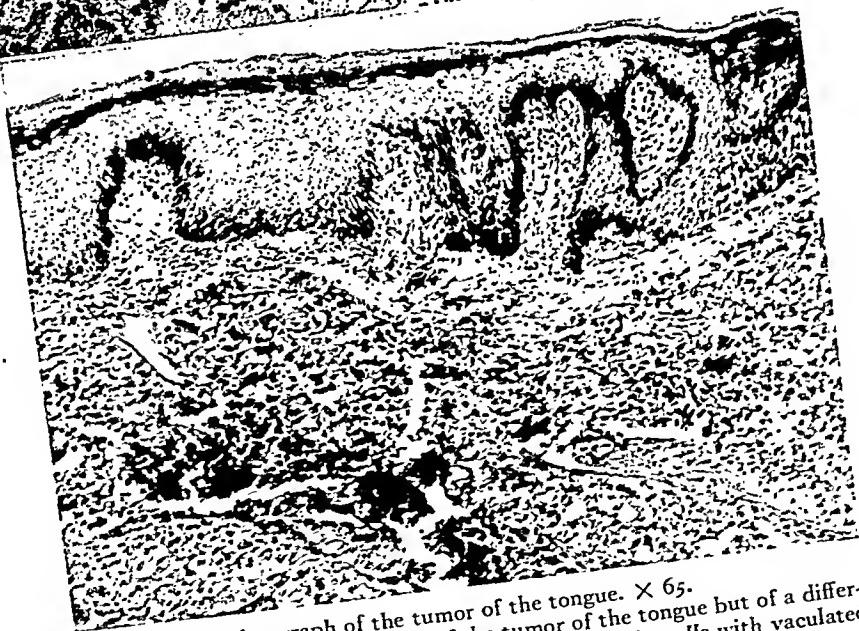


FIG. 5.

FIG. 4. Photomicrograph of the tumor of the tongue.  $\times 65$ .

FIG. 5. High power magnification of the tumor of the tongue but of a different slide showing large, hyperchromatic, lamella-like cells with vaculated nucleus and some mitotic activity.  $\times 150$ .

type II associated with Schimmelbusch disease."

Urine examination showed the presence of epithelial cells and pus cells. The red blood cell count was 4,600,000; leukocytes 8,400; hemoglobin 90 per cent.

The patient was operated upon by us on March 9, 1942, at the Manhattan General

and the mouth were completely packed off with wet gauze packs. A wedge-shaped section of the tip of the tongue bearing the tumor mass was excised with a high frequency knife. The excision extended into healthy appearing tissue. Three interrupted mattress sutures of No. 2 suture were inserted to control bleeding. Superficial bleeding was controlled by electro-

coagulation. The mouth was aspirated of all secretion and blood. The postoperative course was uneventful and the wound healed fairly rapidly.

The pathologic report of the tumor of the tongue was given by Dr. Angelo Sala.

*Gross Examination.* "The specimen is a conic shaped mass, about 8 mm. in diameter and as much in height, covered by ulcerated and disintegrated, friable, hemorrhagic membrane. The cut surface disclosed a creamy yellowish homogenous tissue, compact, but rather soft.

*Histologic Report.* (Figs. 4 and 5.) "The anatomical markings of the cross sections through even the superficial layers of the tongue are completely unidentifiable and replaced by large extension of atypical epithelial tissue consisting of large hyperchromatic lamella-like cells which show a large vacuolated nucleus, some of which reveal mitotic activity. The cells are arranged in cords and nests and do not show any tendency to formation of acini. The superficial layers are disintegrated and covered by blood clots."

*Diagnosis.* "Squamous cell epithelioma, histologically grade II."

Dr. Sala, Dr. Ewing and Dr. Satenstein who studied both the original slide of the breast and that of the tongue reported that the tongue lesion was a metastatic carcinoma from the breast.

On April 27th, a small painless nodule was palpable in the subcutaneous fat in the left femoral region. It was removed under local anesthesia. The histologic report was like that of the original breast and tongue tissue. While in the hospital the patient complained bitterly of pain in the knees and right ankle. Roentgenograms failed to show evidence of metastatic involvement.

She was placed on a high vitamin and liver diet. She also received liver injections, 2 cc. of the crude liver (2 units per cc.) three times weekly, intramuscularly. The right cheek, neck and chest were exposed to deep x-rays. The patient, however, continued to go rapidly downhill with symptoms of cerebral metastases as indicated by complaints of severe pains in the head with partial and subsequent total loss of vision.

#### COMMENT

It has been known that carcinoma of the breast metastasizes primarily through

the lymphatics and occasionally through the blood stream. Numerous cases have been reported in the literature of bizarre sites of metastatic involvement. However, a search of the literature including the Index-Catalogue of the Library of the Surgeon General's Office failed to disclose any case of metastasis from carcinoma of the breast to the tongue. It is interesting to note that while the tongue is often the site of primary carcinoma, the incidence of cancer from any source metastatizing to the tongue especially to the tip of the tongue is most unusual and very rare. Dr. Ewing in a personal communication to one of us (I. F.) stated that he had never seen or heard of a similar incidence. Ochsner and DeBakey<sup>1</sup> reported a series of 3,047 collected cases of primary carcinoma of the tongue with an incidence of 1.6 per cent metastasis to the tongue. The authors do not state into which portion of the tongue the metastases occurred. Warren and Witham<sup>2</sup> state that practically every organ or tissue of the body has been noted as a site of metastasis but they do not mention the tongue. Neither is the tongue mentioned in the literature to which they refer.

#### SUMMARY

An unusual case of carcinoma of the tip of the tongue metastatic from the breast is reported by us.

A search of the literature failed to reveal a similar occurrence.

The authors wish to express their sincere thanks to Dr. Sala, Dr. Ewing and Dr. Satenstein for their examination and report of the slides and to Dr. Gerald W. Sinnott of the Medical Center of Jersey City for his co-operation.

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# AN ANOMALY OF THE FINGER NAIL FOLLOWING TRAUMA

CAPTAIN GLENN A. H. DEIBERT, M.C.  
EDGEWOOD ARSENAL, MARYLAND

THE fingers and nails of manual workers are subject to frequent injuries of various kinds. The loss of a

a division of the matrix and the production of a double-nail formation. In both instances an apparently normal nail occurred



FIG. 1. A dorsal view of the second, third and fourth fingers of the left hand three months after the injury. On the ring finger a normal nail is regenerating. On the middle finger the nail is growing toward the base of the finger and is presenting over the distal interphalangeal joint. A thin, scale-like structure is shown in the normal position of the nail which was not nail substance.

nail following trauma is common. Usually the nail regenerates, but in severe injuries to the matrix, the nail may not regenerate or it may regenerate and be deformed. In rare instances a division of the matrix may cause the production of two nails on the same finger. In very rare instances the matrix may become so dislocated and turned by the trauma to cause the nail to grow toward the base of the finger.

## LITERATURE

There are many references in the literature concerning nail abnormalities, but those due to accident are rare. Heller<sup>1</sup> and Siding<sup>5</sup> described similar cases in which a contused laceration of the finger tip caused

in its normal position. Over the lateral half of this nail a second nail had grown from a point just proximal to the normal nail. This narrower second nail was unattached save the base from which it sprang. Heller<sup>2</sup> also reported a case of lupus vulgaris of the left small finger which caused destruction of the finger except for a small dark brown nail, located at the metacarpophalangeal joint. Its direction of growth was toward the base of the finger.

Pribram<sup>3</sup> reported a case in which a finger was badly contused and lacerated, and after healing, two separate nails had formed on the finger. A larger nail had regenerated in the normal location. About

1 cm. proximal to the nail fold, over the distal interphalangeal joint, a smaller second nail had formed. This secondary nail was half as wide as the normal nail and occupied the lateral half of the width of the finger. It possessed a normal nail bed. No lunula was present on either nail. There was no mention made of the direction of growth, but apparently it grew toward the base of the finger. It appeared that a portion of the nail matrix was dislocated by the trauma and transplanted with the resultant production of a second nail slightly proximal to the normal location of the nail.

#### CASE REPORT

H. W., a white, male, aged twenty-four years, a civilian worker at the Edgewood Arsenal, sustained a severe contusion of the distal phalanges of the third and fourth fingers of the left hand while moving heavy equipment through a doorway. A subungual hematoma developed under the nails of these two fingers. There was no evidence of injury to the skin and no dislocation nor destruction of the nails of either finger. An x-ray revealed an incomplete r-shaped fracture of the distal phalanx of the middle finger. A small opening was made into each nail and the accumulated blood was released. Both fingers appeared to heal without incidence.

One month after the accident both nails were lost. Both nail beds appeared to be normal and there was no evidence of infection. In another two weeks a normal nail was appearing on the ring finger. On the middle finger a thin, scale-like structure was appearing in the nail groove which at first was thought to be a nail. At the same time a slight prominence of the area 1 cm. proximal to the nail fold of the middle finger was observed. This prominence slowly increased in size and gradually began to extend proximally across the distal interphalangeal joint. The skin over this swelling appeared normal. There was no tenderness or fluctuation. The cause of this tumefaction was not understood.

About three months after the original injury a small longitudinal incision was made over the swelling on the dorsal aspect of the middle finger with the belief that this might be an infectious process. No purulent material was

encountered. Several days later, while probing the wound, the nail was discovered in the floor of the wound. (Fig. 1.) Under local anesthesia



FIG. 2. Showing the appearance of the nail after it had been removed, superimposed upon the patient's right middle finger, demonstrating the relative size and position.

the nail was removed. It was found to be of the same length but only half as wide as the average finger nail. (Fig. 2.) This nail possessed the characteristics and thickness of a normal nail. The base of the nail was tapered and appeared to spring from the location of the normal nail matrix. A normal nail bed was present. This nail possessed no lunula. The patient was seen four months after the removal of the nail at which time there was no recurrence of the nail in its normal position or in the abnormal position described.

#### COMMENT

It is generally considered that the cells of the stratum germinativum covering the greater part of the nail bed do not pro-

duce any of the overlying horny material. This function is reserved for the germinative cells beneath the crescentic white area, the lunula, and its extension backward beneath the nail fold, the root of the nail. A nail grows in length by the proliferation of the cells of the stratum germinativum at the root of the nail and in thickness from that part of the stratum germinativum which underlies the lunula. When the nail is torn off or detached through inflammation, it may be regenerated if the cells of the stratum germinativum have not been destroyed.

In the case reported, the severe contusion and the resulting subungual hematoma caused a separation of the nail plate from the nail bed. On the ring finger there was normal regeneration of the nail, but on the middle finger the nail grew in the opposite direction. In the latter instance the germinative elements apparently became dislocated by the trauma and were turned toward the base of the finger. An adequate blood supply may have been retained, or the fragment may have thrived in the surrounding lymph until circulation was re-established, as in grafted epithelium.

At first it was thought that there were nails growing in two directions: one in the normal distal direction and one in the abnormal proximal direction, as suggested in Figure 1. This thin, scale-like structure

occurring in the position of the normal nail, however, probably represented desquamated epithelial cells from the nail bed, or an actual attempt by the stratum germinativum to regenerate a nail in its normal position. This scale-like structure later disappeared and after the nail, which was growing proximally, had been removed, the finger was left without any nail substance.

An excellent article on plastic surgery of the finger and toe nails by Sheehan<sup>4</sup> describes a method by which a nail graft might replace the lost nail on this middle finger.

The author is grateful to Dr. J. Parsons Schaeffer, Professor of Anatomy, Jefferson Medical College, Philadelphia, to Lt. Col. C. F. Murbach, Surgeon, and Capt. J. K. Task, of the Station Hospital, Edgewood Arsenal, Maryland, for their interest and suggestions in the preparation of this article.

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## Editorials

### WHY THE RUSH?

**W**E are up to our necks in a war to the finish—unconditional surrender.

Under the terms of Lend Lease we are supplying our allies with all necessities from food to bombers. This will cost us many billions of dollars. Our national debt is beyond human comprehension. Over ten million of our men will be in uniform. One out of every three physicians in the country will be in "service." God alone knows when it will end. The finish may come six months from now—six years from now—who knows? We are urged by those in high places to sacrifice, toil and sweat, that everything must be put aside and forgotten unless it is essential to the war effort until victory is ours. The American public is doing its part, and more.

But the politicians, it seems, have time for other matters, matters far removed from war. One of their monster schemes, if made into law, will affect every physician in the land as well as every employer of labor and many civilians. It will cost billions in dollars every year.

Shortly to come up for consideration is the Wagner-Murray-Dingell bill (Senate Bill 1161). This bill is defined by its sponsors as follows:

"To provide for the general welfare; to alleviate the economic hazards of old age, premature death, disability, sickness, unemployment and dependency; to amend and extend

the provisions of the Social Security Act; to establish a Unified National Social Insurance System; to extend the coverage, and to protect and extend the social-security rights of individuals in the military service; to provide insurance benefits for workers permanently disabled; to establish a Federal system of unemployment compensation, temporary disability, and maternity benefits; to establish a national system of public employment offices; to establish a Federal system of medical and hospitalization benefits; to encourage and aid the advancement of knowledge and skill in the provision of health services and in the prevention of sickness, disability, and premature death; to enable the several States to make more adequate provision for the needy aged, the blind, dependent children, and other needy persons; to enable the States to establish and maintain a comprehensive public assistance program; and to amend the Internal Revenue Code.

"Introduced—U. S. Senate—June 3, 1943.

"Read twice and referred to the Committee on Finance.

#### Exceptions

"Under Senate Bill 1161 all employes and all self-employed individuals pay taxes to and become beneficiaries of the Social Security Trust Fund except: (1) casual laborers not engaged in their employer's business; (2) individuals employed by children or spouse, and children under 21 employed by their parents; (3) ship employes working on a foreign vessel when outside the United States; (4)



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carrier employees or their representatives; (5) certain employees of labor, agricultural and other non-profit organizations; (6) employees of foreign governments or of instrumentalities owned by a foreign government; (7) employees of the United States or of an instrumentality owned by the United States, not including Tennessee Valley Authority employees hired on an hourly basis; (8) State or municipal employees or employees of any instrumentality owned by the foregoing; and (9) ministers and regular members of religious orders."

This Bill proposes placing in the hands of the Surgeon General of the Public Health Service the power (and authority) to employ physicians and establish the rate of their payment, to establish fee schedules for their services rendered, to establish qualifications for specialists, to determine the number of patients whom any physician may treat, and to determine what hospitals or clinics may provide services for the sick.

Under the provisions of the bill every employer shall pay a tax of 6 per cent on wages paid to employees up to \$3,000 a year. Every employee shall pay a tax (taken out of wages on earned income up to \$3,000 a year) of 6 per cent. This means a tax from payrolls of 12 per cent. Every self-employed person shall pay a tax of 7 per cent on the market value of his services up to \$3,000 a year. And Federal, state and municipal employees (under certain conditions) shall pay a tax of  $3\frac{1}{2}$  per cent.

The Bill provides for the establishment of a fund—"Federal Social Insurance Trust Fund"—and into this all Social Security taxes would be paid—\$12,000,000,000 annually. On the basis of this income a minimum of \$3,000,000,000 annually would be transferred from the Trust Fund to the Medical Care and Hospitalization Account. There are those who claim that \$8,000,000,000 would be nearer the correct figure.

A great deal has been written on this subject; organizations have gone on record

against it (i.e., American Bar Association, Chicago, August 23-26), and those of the medical profession still at home are, for the most part, apprehensive of the future. However, for the sake of argument let us assume that the American public needs this form of medical care; let us assume it would be beneficial to both Mr. Common Man and Dr. Physician and not a visionary panacea representing zero minus in end results; the whole thing at this time is too radical, too different, too loaded with T.N.T. to be considered and slipped over on the public. Our minds are too full of the war. Too many of our men are in uniform and out of the country. A third of our physicians, a great majority of them in their most active years, are in uniform and they surely are more concerned with the medical problems of war than with the economics of medicine. So why at this time, when men's minds are concerned with a successful termination of a ghastly business are we, the American public (lay and professional), to be burdened with this issue? This is no time for political tricks.

All of us of mature age remember how the Prohibition farce (and most of it was anything but a farce) was slipped over while a war was engaging the minds of our people. Is this the time to repeat history? If the proposed legislation has merit, cannot the whole thing wait until that day when all of us have the time, inclination and mental poise to consider it? What's the rush? Why not put it on ice until after the war is over?

We received a small brochure on this subject and there is a sentence on the back cover of this pamphlet which all of us can ponder and take to heart. It is from the writings of the Hon. Winston Churchill who said, "We must beware of trying to build a society in which nobody counts for anything except a politician or an official, a society where enterprise gains no reward, and thrift no privileges."

T. S. W.

## TISSUE BANK

THE advisability of a plan for the conservation of material has been sorely needed for the wounded during active campaigns and during the period of reconstruction. Inasmuch as each soldier has a physical examination, blood examination and blood grouping, he is an ideal subject for the beginning of a plan for a tissue bank. This should consist of tendon, nerves, fascia, cartilage, skeletal group bones, flat bones and bones of the cranium. These structures should be removed and preserved for use in the repair of extensive losses of nerve trunks, tendons, joints, etc. It is unnecessary today to remove the crushed bone of the head, whether it be infected or not, in doing a compression. This bone should be conserved; it should be boiled, put through a mild antiseptic solution, and when the laceration, infected brain, and hernia have been controlled, this bone can be reshingled in, and will grow as I have repeatedly demonstrated in the care of wounds.

There is no need today for any metal to be put into the head, even to bridge large gaps. The primary dressing in the first line Mobile Station can be done. The bone can be saved, marked, tagged with the soldier's name, put in a small bag tied around his neck and sent back with him so that later on it can be re-implanted. In this war as in every other we have a severe loss of nerve trunks, tendons and sheaths, joint damage, capsular damage to joints and closure of large explosive wounds by fascial support becomes necessary. At the present time we are depending too much upon foreign material or animal fascial plane in the reconstruction. There is always considerable material which is available along battle fronts or in the immediate vicinity which

can be taken from the soldier who has been killed. Plastic work can be done on the living, with insertion of like blood group material, especially nerve trunks, the orientation of which can be fixed by black silk markings on the dorsal surface, or white silk on the ventral surface, so that the continuity of the fiber may be established in a normal individual.

War injuries are similar to civilian injuries, especially in instances of heavy bodies falling on members of the armed forces causing laceration of soft tissues, multiple fragmentation and often loss of considerable amounts of bone. Again it will be unnecessary to go into the animal field for replacement, if material is made available for the living by the setting up of so-called tissue banks in easily available centers. In regard to severe burns caused by blasting injuries which produce destruction of large areas of skin, I would suggest that large skin banks of like blood groups be established in order to replace considerable areas of skin by simply grafting without additional mutilation of the patient.

This may be extended also to other tissues. There is no doubt that human blood vessels, large arteries, large veins, brachial-plexus divisions and trunks, which are unfortunately wasted today, may be utilized instead of animal material. Tissues of those who have been killed can also be revived. This has been demonstrated as feasible, as the break-down in tissues varies after so-called death from a few hours in a case of brain and several days in a case of the loss of organized tissues; bone remains the longest without change in the dissolution.

WILLIAM J. CASSIDY, M.D.



# Original Articles

## THE PELVIOSCOPIC METHOD OF UTERINE SUSPENSION\*

MAJOR WILLIAM B. HARRELL†

Medical Corps, Army of the United States

NEW ORLEANS, LOUISIANA

**A**BDOMINOSCOPY and peritoneoscopy have been used extensively for the past few years for diagnostic purposes and to some extent for operative procedures.<sup>1</sup> In 1939, Donaldson, Sanderlin and Harrell while working with the peritoneoscope, reported a method of suspending the uterus without open abdominal incision.<sup>2</sup> This operation was performed by passing a special round hooked needle through the lower abdominal wall under peritoneoscopic vision and passing a suture beneath the round ligament pulling it forward for adherence and fixation to the abdominal wall (Olshausen operation).

Upon the suggestion of Joe H. Sanderlin, Professor of Gynecology, the pelvioscope\*\* (Figs. 1 and 2) was designed to give the operator direct vision into the pelvic cavity. We believed that direct vision with this type of instrument would be more satisfactory than the indirect visualization or endoscopic examination of the same with a lens instrument. In addition, it appeared that this route of entry into the abdominogenital region of the abdominal cavity would facilitate greater means of operability upon the pelvic viscera.

### DESCRIPTION OF INSTRUMENT

The pelvioscope is similar in many ways to other body cavity scopes affording direct

\*\* The author wishes to express his appreciation to Mr. Frederick E. Lenhart, machinist, Evansville, Indiana, for his untiring efforts in the designing and construction of the pelvioscope.

\* From the Department of Gynecology, University of Arkansas Medical School and Hospital, Little Rock, and the 210th General Hospital, A.P.O. 837. † Resident and Instructor in Gynecology, University of Arkansas Medical School and Hospital prior to service with the Armed Forces.

vision. The instrument consists of two parts, one of which is a hollow cylindrical tube 11 cm. long and 1 cm. in diameter which acts as a sheath for the snugly fitting trochar-pointed obturator, which has a tapering triangular cutting point that extends approximately 4 cm. below the sheath. The upper end of the obturator has a rounded handle which fits into a cup-like beveled upper portion of the sheath. The instrument is made of stainless steel and is plated with chrome. It is constructed in such a manner that when fitted together it can be used as a trochar.

The field of vision is lighted directly by means of a small electric light which is slightly offset and fitted to the cylinder. (Fig. 3.) It is attached to a small tube which clamps to the inside of the cylinder and lies flat along its surface, affording the least possible interference with the operative and visual fields.

The special, dull, round ligament hook (Figs. 1 and 2) is best used with this instrument for uterine suspension. The hook consists of a tapering match-stick sized steel rod with a dull flattened pencil sized hook on one end. The instrument is 18 cm. long and fits into a small handle which facilitates easier manipulation. Like the pelvioscope it is chrome plated.

### INDICATIONS

We believe this procedure to have moderate usefulness in that it may be performed successfully on those cases of

uncomplicated retroversion and retroflexion that appear to be producing symptoms. In many cases of this type, we believe

arotomy can, we believe that more of these patients may conscientiously be advised by the physician to undergo operative



FIG. 1. A, the pelviroscope has been thrust through the abdominal wall and is now in place for removal of the obturator. B, after removal of the obturator the light stem with bulb attached is inserted into place where it is clipped to the wall of the instrument and visualization of the pelvic viscera accomplished.

that there is some hesitancy by the surgeon in subjecting the patient to an elective laparotomy that may or may not give symptomatic relief. If a satisfactory method of uterine suspension can be employed which does not require open abdominal incision nor have the possibility of producing the many complications that lap-

correction. Because of the fact that we are again presenting a new technic for performing an established method of uterine suspension (Gilliam operation) we do not feel any hesitancy in predicting the end results. It may be said that this technic for performing the Gilliam operation will undoubtedly tend to broaden the indica-

tions for uterine suspension. According to Dannreuther, the Gilliam type of suspension causes very little trouble in the

preoperative medication is given. We prefer, however, a spinal or general anesthetic because of the ease with which the pelvic

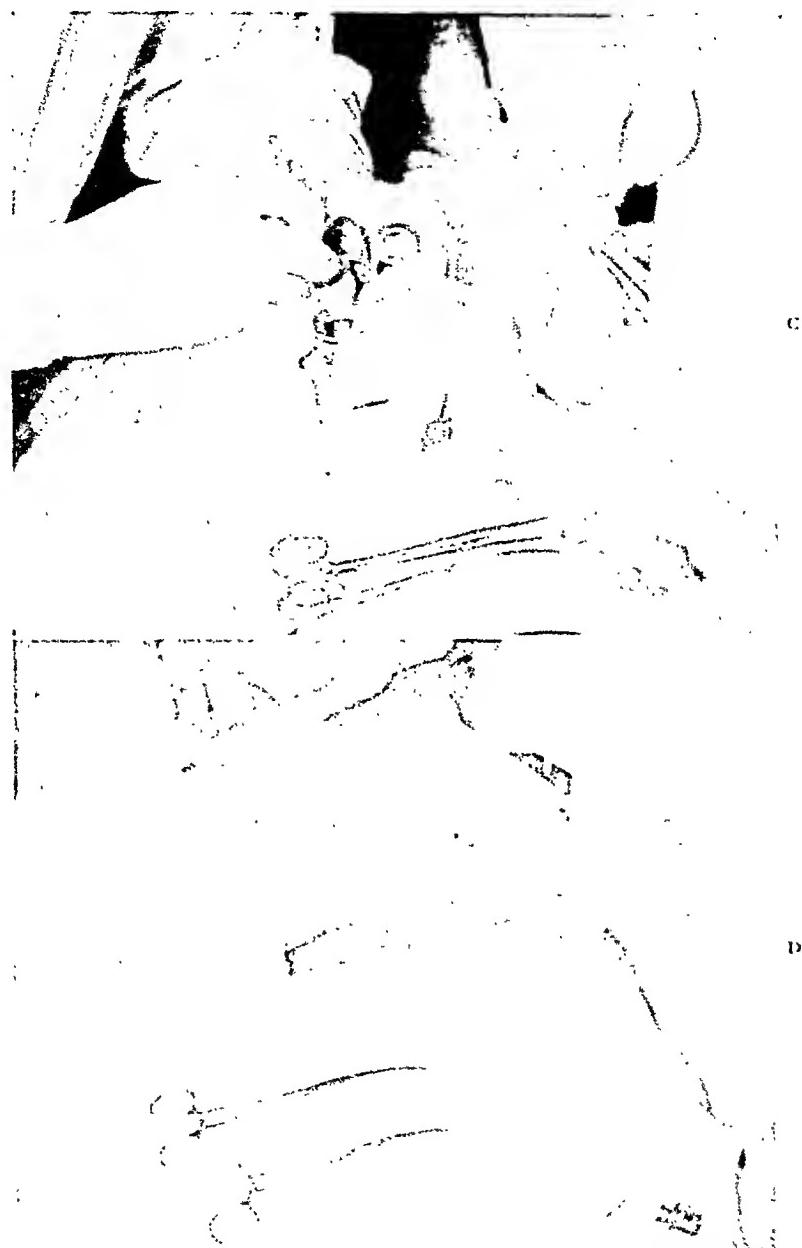


FIG. 1. C, the round ligament hook has been inserted beneath the round ligament pulling it forward to a point outside the fascial level. The light has been removed and the sheath is about to be slipped out of the wound over the hook. D, after removal of the sheath the round ligament can be seen as it is being pulled forward for the fascial suture.

event of a subsequent gestation and delivery and also is not contraindicated by salpingo-oophorectomy.<sup>3</sup>

#### OPERATIVE TECHNIC EMPLOYED

The uterine suspension may be performed under a local anesthetic if heavy

structures may be manipulated without pain or discomfort to the patient. With the patient in marked Trendelenburg position, a horizontal skin incision is made 1 cm. long at a point 3 cm. above the symphysis pubis and 4 cm. lateral to the midline on either side, depending upon

which round ligament is to be suspended first. The pelvioscope is then held firmly in the same manner as an abdominal

sense of being in the abdominal cavity. If this should occur, it is necessary to remove the obturator and deflect the

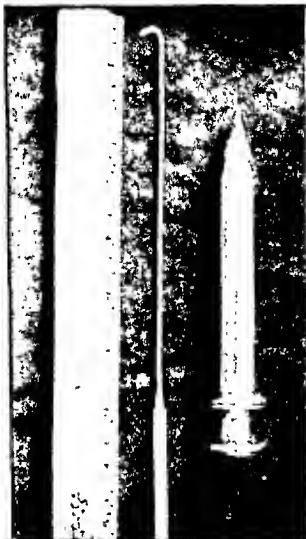


FIG. 2.

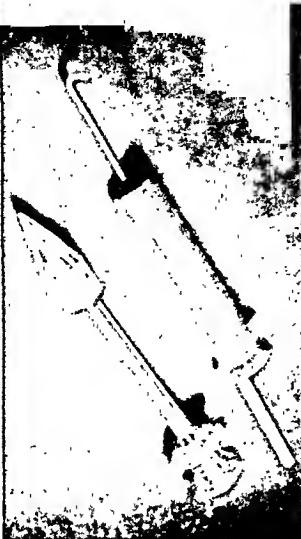


FIG. 3.

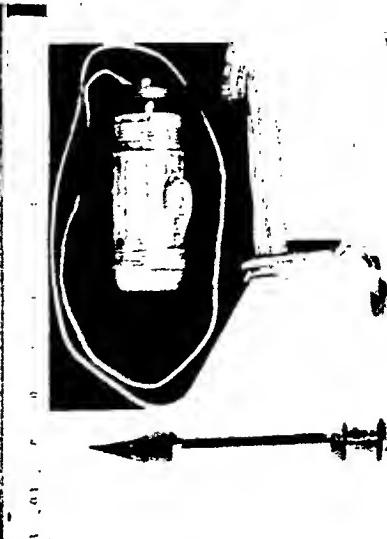


FIG. 4.

FIG. 2. This photograph shows the assembled pelvioscope and round ligament hook.

FIG. 3. Photograph showing the trochar-obturator below and to the left of the sheath which has the round ligament hook protruding through it. The hook is turned up in the manner that it is used to retract the round ligament forward.

FIG. 4. This photograph shows the lighting apparatus attached to the sheath of the instrument. A handle is also attached to the upper part of the sheath for easier manipulation.

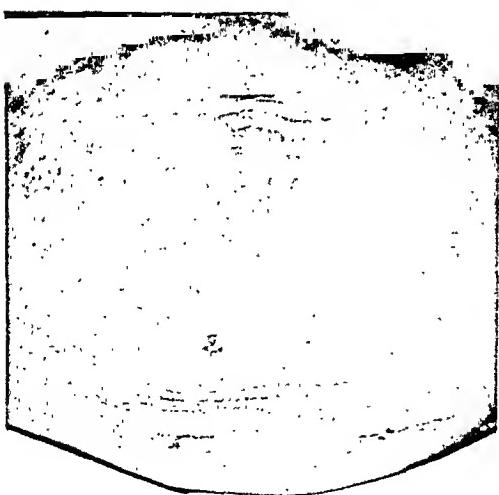


FIG. 5. This photograph shows the edges of the initial skin incisions approximating themselves without the use of sutures or skin clips immediately following this type of uterine suspension.

trochar and thrust through the incision, puncturing the abdominal wall. As a rule the peritoneum is penetrated but it may separate and be pushed ahead of the instrument, giving the operator a false

instrument slightly upward. The obturator is then reinserted and rotated clockwise while being introduced deeper into the abdominal cavity, piercing the peritoneum at an angle of forty-five degrees. Once the abdominal cavity is entered, the obturator is removed and the light stem with bulb attached is inserted into place where it is clipped to the wall of the instrument. The source of light for the visual field is ahead and to the side of the sheath giving a bright direct light field without glare into the instrument. By using a low volt bulb it is never heated enough to injure the surrounding viscera.

After a complete visualization of the pelvic structures in this region, the operator then decides whether or not it will be feasible to proceed with the suspension or perform other operative procedures. The suspension is accomplished by inserting the dull round ligament hook beneath the round ligament and pulling it up through the instrument to a point outside the level of the fascia. The sheath is then slipped

out of the wound over the hook leaving the round ligament in place above the fascial level. The round ligament is then grasped with an Allis forceps, the hook removed, and small right angle retractors used to expose that portion of the fascia medial to the wound. The round ligament is sutured to this fascial area with small silk or crochet cotton interrupted sutures. An interrupted suture may be used to close the puncture wound of the fascia and another suture or skin clip used for the original skin incision. In most cases, however, we do not find it necessary to place sutures in the fascia or the skin. (Fig. 4.) The other round ligament is brought forward in the same manner, thus completing a modified Gilliam operation.

#### REMARKS

A series of twelve dogs were operated upon (the two horns of the dog uterus suspended to simulate the suspension of the round ligaments in the human) before the operation was attempted on a human. After satisfactorily working out a pelvioscope technic the operation was performed on twelve uncomplicated retrodisplacements of the uterus in the human. At no time did we encounter any serious complications and routine postoperative examinations revealed the uteri to be remaining in good position.

Within six hours following this type of uterine suspension we allow the patient to become ambulatory and occasionally some of the patients who have been operated upon under local anesthesia elect to remain ambulatory. It stands to reason that this type operation as compared with open abdominal incision will appreciably reduce the incidence and frequency of postoperative abdominal adhesions and hernia. Also, we believe that there is very little shock associated with this operation and a marked reduction in the danger of postoperative infection or embolism. We believe, too, that the pelvioscope may be used to some extent for diagnostic pelvioscopy but believe this instrument best used for the type operation described above. In using

this type instrument, the visual field will always more or less depend upon the position and condition of the intestines. If the patient has received laxatives and cleansing enemas before operation, responds well to the anesthetic and is placed in a marked Trendelenburg position, it will be possible to visualize most of the pelvic viscera; otherwise the visual field will always be distorted to some extent. We believe, however, that the round ligaments can be identified as such in most all cases if the pelvioscope is inserted at the proper level in the lower abdominal wall. For this reason the uterine suspension can be accomplished when other operative procedures are prohibited.

#### SUMMARY

1. A new instrument has been presented which will allow the surgeon a direct visualization of the pelvic viscera without performing a laparotomy.

2. We have described a new technic by which the Gilliam type of uterine suspension may be performed without open abdominal incision, by use of the pelvioscope and special round ligament hook instrument.

3. By performing this operation without open abdominal incision the patient may become ambulatory the first postoperative day and the period of hospitalization reduced to one or two days.

4. A new approach to operative gynecology is presented in the hope that it will serve as a stimulus to other workers who will become interested in this surgical field.

The author wishes to express his appreciation to Dr. Ralph Estevez, of Aguadulce, R. de P., for his contribution of clinical material as well as for his advice and constructive criticism in the development of this surgical technic.

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# MARCH FRACTURE OR INSUFFICIENCY FRACTURE\*

MAJOR SAMUEL HAROLD NICKERSON,  
CAMP MAXEY, TEXAS

MARCH fracture has come very much to the foreground ever since our citizen army clothed itself in uniform and went into strenuous military training. Explanations concerning its etiology have been numerous. A factor common to all presented explanations is the emphasis placed on a clinical history of protracted stress and strain, occasioned by muscular activity over prolonged periods of time, by excessive drilling and marching. Another point common to all histories is the repeated appearance of this lesion in individuals who up to a comparatively short time ago were engaged in relatively inactive pursuits during their daily routine.

The clinical behavior of these patients has often been described and will therefore not be repeated here. Suffice it to say that the pain and disability are rather insidious at times; on other occasions almost dramatic in onset and severity. Indeed, in many the true state of affairs had not been suspected until a lump in the metatarsal shaft was readily palpated and then substantiated by roentgenograms. From a review of the literature, the concensus of opinion is that march fracture most commonly occurs in the second metatarsal shaft, less commonly in the third and rather infrequently in the fourth bone.

A few cases of a similar lesion have been reported in the femur. The most recent reported case to come under observation is the one described by L. T. Peterson.<sup>1</sup> His x-rays showed a small oblique fracture in the adductor aspect of the femur at the level of the distal second and third fourths. The direction of this oblique break is surprisingly similar to that which is seen in metatarsal cases. The vast majority of these cases show the obliquity of the break

to run from the cortex downward distally and inward toward the medulla.

The writer has had the opportunity to observe two unusual lesions in the pubic bone. The similarity between the pubic lesions and those observed in the femur and metatarsal bones was suspected when the first case, reported below, presented itself. It was confirmed in the second case in which an identical lesion was found.

## CASE REPORTS

CASE I. This man, aged thirty-four, an infantryman, had been in service for approximately three and one-half months. He had been engaged in simulated combat maneuvers, when he began to experience some pain along the adductor aspect of the left thigh. There was no history of trauma, rather one of slow insidious onset. About six weeks after its onset, the pain radiated as far as the perineal region, and the patient came to the clinic for examination. A course of physiotherapy was prescribed, since a few similar cases responded to this regimen without incident. However, he failed to improve, and further examination revealed marked tenderness close to the pubic bone. Roentgenograms were ordered and they revealed a hazy line (Fig. 1) of decreased density traversing the left inferior ramus of the pubis, in a vertical manner, with a small amount of periosteal proliferation, at its proximal end, close to the periphery of the obturator foramen. No other break in the pubic ring was seen. He was hospitalized to bed rest and he cleared up completely, symptomatically.

CASE II. This man, aged twenty-five, came to the clinic complaining of pain along the adductor aspect of the right thigh. He was an infantryman. Here again, the onset was insidious, and could not be related to any acute traumatic incident. This man also failed to respond to a regimen of physiotherapy. Benefiting from the expericnce of the first case, roent-

\* From the Orthopedic Section, Station Hospital, Camp Maxey, Texas.

genograms were taken and revealed a zone of rarefaction and periosteal reaction similar, in every respect, to that seen in the first case. His

this reparative process. The initial pathological disturbance would have become entirely masked, and obliterated, thus viti-



FIG. 1. A hazy line of decreased density traversing the inferior ramus of the left pubic bone. Early periosteal callus can be seen in its upper end at the margin of the obturator foramen.

condition also completely cleared up with bed rest and physiotherapy. (Fig. 2A.)

Camp and McCullough<sup>17</sup> presented a case of pseudofracture, involving the upper and inferior pubic rami, bilaterally in the same pelvis, resulting from an osteomalacia caused by dietary insufficiency. The lesions in the inferior pubic rami were identical with, and could not be distinguished from those in the two cases reported above. The etiology in the writer's two cases was that of excessive muscular exercise and obviously not of any dietary deficiency. At this point, the writer decided to review the entire available literature concerning fracture due to prolonged marching or exercise. It seemed to the writer that a new concept of its pathology had to be formulated in a manner sufficiently clear to reconcile a similar lesion in three widely dissimilar bones. At the beginning of this study it was believed that no appreciative value could be derived from the investigation of old cases which showed, by x-ray, well organized fusiform callus, since these old lesions would have been overrun and already obscured by

ating any attempts of detailed study. The problem became one of greater vigilance and constant suspicion of its presence in all likely cases, in order to capture the culprit in its earliest periods of depredation. The result has been a small series of cases in which the necessary conditions for early study obtained. Tracings were made of the involved metatarsal bones in such a manner that the lateral aspect of each shaft faced in the same direction regardless of whether they were from the right or left foot. This sometimes necessitated reversing the film in order to make the tracing. (Figs. 3A and B.)

#### ANATOMY

A study of the anatomy of the pubis, femur and metatarsal bones reveals the fact they are acted upon by large muscle groups. In the case of the metatarsal bones the volume of the intrinsic musculature is comparatively large in proportion to the size of each shaft. *The writer believes that great importance should be attached to the fact that the attachments of these muscles are in the form of large fleshy bellies that are unlike*



FIG. 2. A, zone of rarefaction identical in every way with that shown in Figure 1. Here the lesion is on the right side.

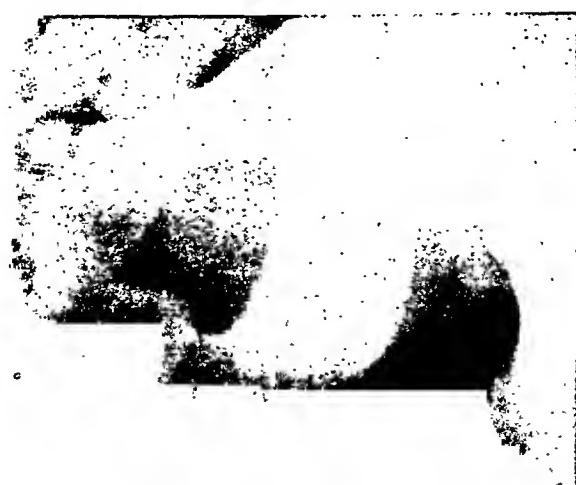


FIG. 2. B, since the completion of this paper, an additional case of insufficiency fracture of the pubic bone has been found. The clinical history is quite similar to the other two reported cases. Here, however, the lesion is comparatively old and shows the overgrowth of callus. For purposes of research this case would contribute nothing to the solution of the problem since all the finer roentgenographic details have become obscured.

*the skeletal anchorages of such tendons as the biceps, triceps, quadriceps, and tendo achilles. In the case of the pubis, the ad-*

*the middle and third phalanx of each toe. The dorsal interossei abduct the toes on the second. The plantar group adducts the toes*

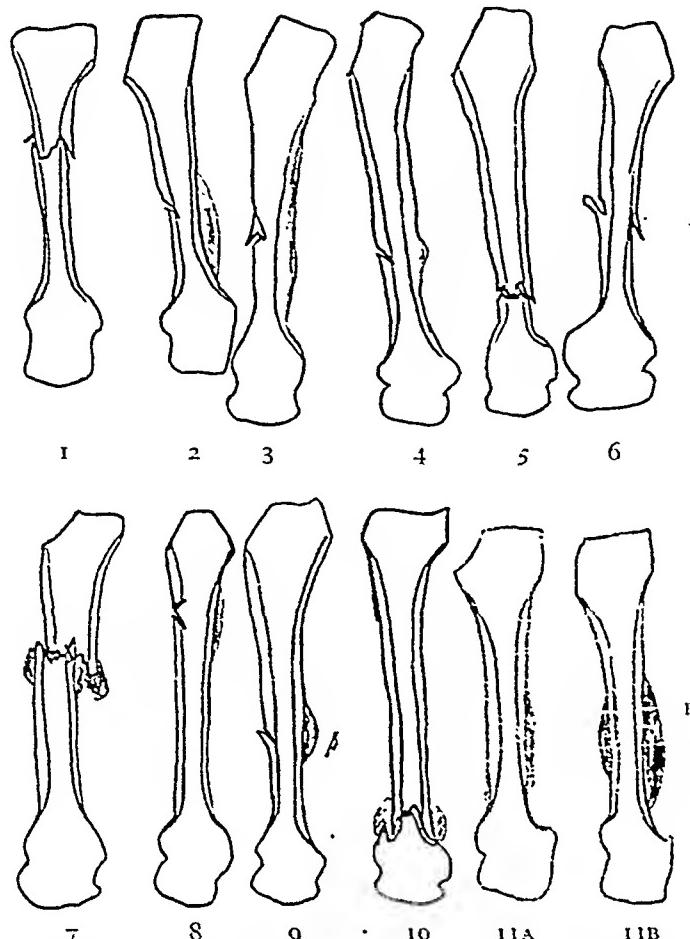


FIG. 3. A and B, the lateral aspect of each bone faces in the same direction. Similarly, the medial aspect of each bone faces toward the reader's right. It will immediately become apparent that the first break in the cortex is almost always along the lateral aspect of the metatarsal shaft. It is also clearly evident that the first periosteal changes are always on the side contralateral to the break. (Numbers under each drawing refer to case numbers tabulated in the table of "Case Analyses.")

ductor magnus is important. In the case of the femur, it is the vasti and the adductor muscle groups. In the metatarsals, the interossei must be considered. (Fig. 4.) In the case of the pubis and femur, the line of pull of the adductor magnus and vasti is quite clear and uncomplicated. In the case of the foot, a highly complicated mechanical system exists. For the purposes of this paper, however, consideration will be restricted to the interossei which are arranged into dorsal and plantar groups. Both groups flex the proximal phalanx and extend

on the second. The two medial dorsal interossei counterbalance each other in their action on the second toe. Thus, the three plantar interossei with their adduction action would tend to be overactive, compared with the two remaining dorsal interossei. (Fig. 4.)

The position of the metatarsal bones, in their relationship with the cuneiform bones, tends to place the outer four metatarsals in an adducted position. A normal foot, during normal locomotion, is slightly inverted just before it is planted squarely on

## CASE ANALYSES

Case No.	X-ray Findings	Periosteal Proliferation	Phase
Case 1 No. 3019.....	Usual oblique fracture on lateral aspect, with slight lateral "sliding" of distal fragment; lifting up a small cortical chip on proximal fragment	None	Rapid 1 and 2. Phase 3
Case 2 No. 2088.....	Very fine oblique fracture, lateral side; fuzzy early periostitis on medial side; very slight periosteal reaction on lateral side	Chiefly on medial side	Phase 2
Case 3 No. 8768.....	Usual oblique break; very little "sliding" with elevation of cortical chip on proximal fragment; well formed thickened periosteum on medial side	Well formed; medial side	Latter half phase 2
Case 4 No. 9008.....	Very faint oblique break on lateral side, incomplete through cortex; early periosteal reaction on medial contralateral side	Early reaction on medial side	Phase 2
Case 5 No. 8481.....	Irregular break through entire shaft; initial lateral break not seen here	None	Rapid 1 and 2. Phase 3
Case 6 No. 6903.....	Usual lateral oblique fracture; another cortical fracture on medial side; "sliding" of fragments causing elevation of cortical chips on both sides, and a condensed line in medullary area due to "impaction" resulting from the sliding together	None	Rapid phase 1. Middle of phase 2
Case 7 No. 7011.....	The oblique lateral break progressing to a complete fracture of shaft; lateral displacement of distal fragment	Callus advanced	Late 3rd phase
Case 8 No. 9023.....	Usual oblique lateral break; very early, and incomplete through cortex; early periosteal reaction on contralateral side; faint line can be seen to be extending across shaft to mid-periosteal reaction	Early periosteal reaction	Latter part of phase 2
Case 9 No. 8893.....	Very fine oblique break; incomplete through lateral cortex; early fuzziness of periosteal reaction on contralateral side	Early periosteal reaction	Middle of phase 2
Case 10 No. 2519.....	Fracture complete through metatarsal neck; completed callus formation; sixteen days earlier, identical picture with no periosteal reaction at all	None in initial x-ray; advanced callus formation sixteen days later	Rapid 1 and 2. Late phase 3
Case 11a No. 7556.....	Very faint periosteal reaction along medial aspect of shaft; no other changes noted (a march fracture anticipated)	Very early periosteal reaction	Phase 1
Case 11b No. 7556.....	Same as above three weeks later; medial side shows advanced periosteal reaction; lateral side shows much less reaction	Both sides; medial side more pronounced than on lateral side	Late phase 2

The last case reported shows the earliest stage which was picked up clinically. Indeed, the actual x-ray picture showed the changes much less distinctly (and could easily have been overlooked) than the tracing depicts it. However, he went on to show the usual findings. Noteworthy is the fact that he did not show the usual oblique break caused by the "sliding" or over-riding of the laminated layers of the lateral cortex.

*Summary of Analysis of the Cases.* (1) The earliest x-ray evidence is faint; fuzzy periosteal reaction along the medial side of the shaft. (2) The next finding is of a break through the lateral cortical thickness. This break is at first incomplete so that it does not extend across the entire cortical thickness. (3) There is more advanced periosteal reaction on the medial side. The outer layers of the lateral cortex have parted in a manner to suggest that they have been "burst" in that direction. Others show changes which indicate that in addition to this, there has been some minute internal collapse so that minute over-riding occurs. The x-rays which show small chips "shoved off" the proximal cortex, by this sliding by of fragments, probably include this group. (4) Stages of condensation of the periosteal proliferation with maturation into normal callus obscuring all the finer roentgenographic details.

the ground. The first impact is, therefore, received on the outer margin of the metatarsus, before the first metatarsal head is

weight-bearing stress than the third. Similarly, the third bone will more often be involved than the fourth, for the same rea-

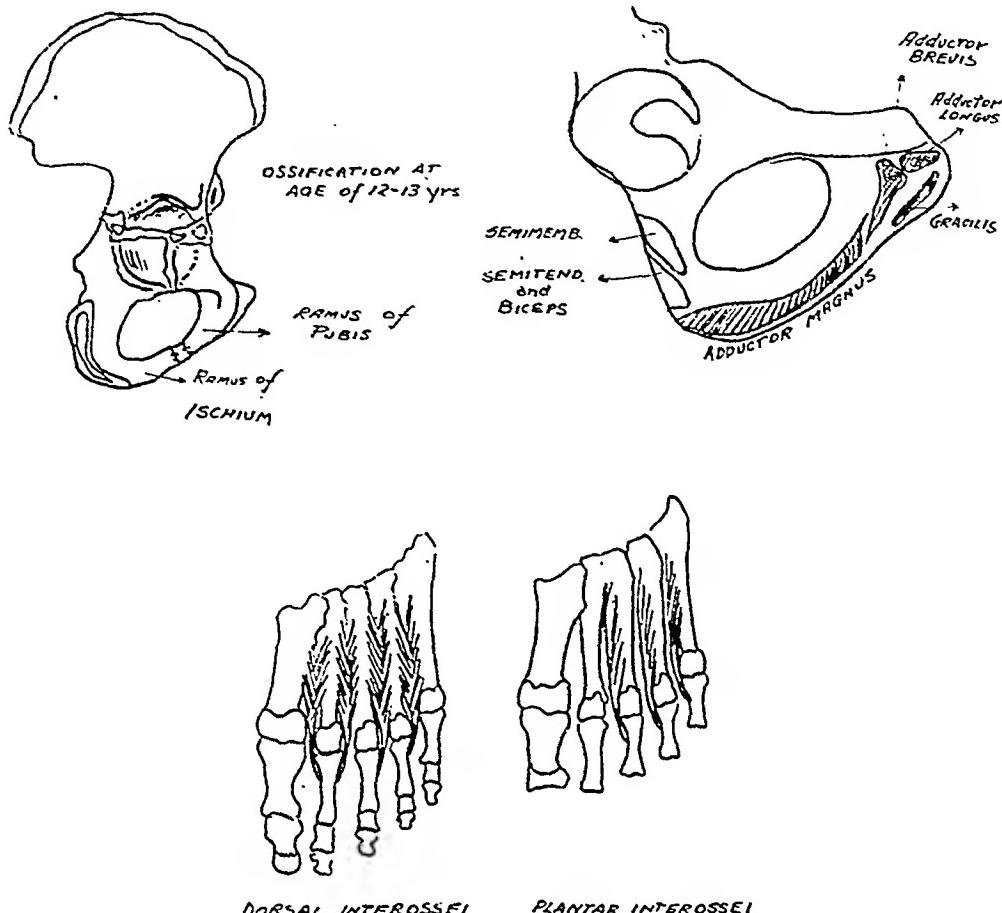


FIG. 4. Drawing showing the anatomy of the pubis, femur and metatarsal bones.

brought to the floor or ground. This observation was made by watching many feet go up the long corridors of the Station Hospital with the subject being totally unaware of being observed. This was deemed necessary since any consciousness on the part of the subject inevitably resulted in an assumed and unnatural gait.

Therefore, the action of the interossei, the normal adducted attitude of the metatarsal bones and the lateral impact to the metatarsus on locomotion, all tend to throw an adduction strain on the metatarsal bones. This would make itself felt chiefly on the second, third and fourth bones, since they are less ruggedly built than the first and fifth bones. Furthermore, the second metatarsal will bear the greatest brunt of this force since it endures a greater

strain. Thus, for our purposes, we must consider the pubis to be acted upon by a force downward distally. The vastus medialis and the adductors are the chief strain-producing muscles in the production of the femoral lesion. The strain-producing factor in the metatarsus has been described above.

The salient difference between large fleshy bellies, which constitute all of the above mentioned muscles, and tendinous structures, is that the latter are comparatively avascular and the former highly vascular.

#### PATHOLOGY

For obvious reasons no anatomical or microscopic material has been available. F. H. Straus<sup>2</sup> has reported the gross appearance of one specimen which was excised for

the reason that neoplasm was suspected. None of the x-rays taken of his patient's foot revealed a fracture line. The usual globular or fusiform callus was seen. The longitudinal section of the bone, however, revealed an oblique line of fracture, which at no time had been visible by roentgenograms. There was no displacement of the fragments, which retained their perfect alignment. Michaelis<sup>3</sup> found some loss of lamellar structure in the compact bone. Honigmann<sup>4</sup> found only an increased lacunar absorption and development of mesh-like bone *without calcification*. Gratsianskiy,<sup>5</sup> Leedham-Green and Golding<sup>6</sup> found nothing characteristic in the microscopic sections and stated that histological investigation of the bone was of no help in the cases studied. Allen and John<sup>7</sup> examined two cases and found essentially the same features as Honigmann. In general, a section through the zone of absorption showed an inactive type of bone with a few osteoblasts present. There were no osteoclasts. In the marrow portion of the break (or zone of decalcification) a few marrow cells were present, but most of the marrow consisted of fat and fibrous tissue.

Search of the literature reveals that it has engaged the interest of European authors much more frequently than American clinicians. This is easily understood in the light of the greater military activity of European countries during the past centuries. Breithaupt<sup>8</sup> explains the condition as due to a tenosynovitis. Weisbach<sup>9</sup> attributed it to inflammation of the intermetatarsal ligaments. Pauzat<sup>10</sup> considered the possibility of an osteoplastic periostitis. Poulet,<sup>11</sup> like Pauzat, thought it was an osteoperiostitis, but called it an "osteopereostite rheumatismale." Momburg<sup>12</sup> decided that it was due to an "elastic bending" of the bony structure over a prolonged period of time. Kirschner<sup>13</sup> believed that the lesion was due to a fracture or infraction of the shaft of the bone, which was often not recognized due to the lack of displacement of the fragments. Jansen<sup>14</sup> postulated that a venous stasis, causing

periosteal proliferation and an internal rearrangement of the bony structure, weakened the bony architecture.

When one studies the lesions observed in the pubis, Jansen's theory seems to be most applicable. The lesions in the femur and metatarsal bones appear to be best explained by the beliefs of both Momburg and Kirschner. As a matter of fact, it would appear to the writer that all three theories are explanations of different phases of the same lesion.

During activity there is an increase in the vascular demand. This would be accentuated by the prolonged activity of the large fleshy bellies of the above mentioned muscles. The effect of this increased local circulatory response over a protracted period of time would result in local nutritional changes. This is reflected in the bone by local decalcification of the skeletal architecture. In the case of the pubis, the zone of linear rarefaction is not unlike the "umbauzonen" described by Looser,<sup>15</sup> or those found in the so-called Milkman's<sup>16</sup> syndrome, which present idiopathic symmetrical pseudofractures. In the periosteum, on the other hand, nutritional changes would produce a proliferative response, with a roentgenological appearance of periostitis or very early callus. Evidence pointing to the initial lesion being a periostitis seems to be confirmed by the findings in Case 11. (Fig. 3.) The area of linear rarefaction on the other hand is best seen in the pubis, since it is very flat and comparatively thin in this portion of the bone—the site of fusion and ossification in the adolescent. It would be more difficult to visualize this zone of rarefaction in its very early stages in cylindrical bone shafts, because the thick cortex and periosteal proliferative process would tend to overshadow it or obscure it. It is only when the bone begins to "give" in its cortex, that the x-rays show a loss of continuity. (Fig. 3.) Sai<sup>17</sup> also performed experiments with two parallel bones. They both showed that mechanical interference with one of the bones would be reflected in a form of a

pseudofracture in the other adjacent bone or bones. This might account for the frequency of formation of pseudofractures

rather hurriedly, an accessory (periosteal) splint to buttress the one which is about to "give way." Indeed, one glance at Figure 3



FIG. 5. A, trabecular system of the metatarsal bone highly magnified. It demonstrates the obliquity of the trabecular system in a lateral direction and might explain the constant appearance of the cortical break which runs in an oblique manner laterally.

(zones of rarefaction) in the second, third and fourth metatarsal bones compared with the first and fifth, since the former are more intimately associated with each other by the intertarsal ligaments, and other ligamentous structures, and would more likely reflect any strain placed on the neighboring bone. When this occurs, the periosteal proliferative process, on the side contralateral to the break, is fairly well advanced. It would seem that nature had built up,

will show that all cases that demonstrated this rapid erection of contralateral callus exhibited only minimal breaks or displacements. On the other hand, Cases 1, 5 and 10 showed no periosteal reaction in their first roentgenograms, and consequently progressed to complete breaks, traversing the entire diameter of the bone.

A study of Figures 1 and 2 will reveal the fact that the periosteal reaction is located in the identical area. A study of

Figure 3 will again reveal the constancy of early periosteal reaction on the *medial* side of the shaft and a correspondingly greater

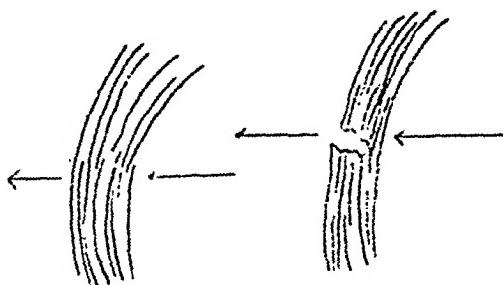


FIG. 5. B, diagrammatic illustration of "bowing" strain on the cortex of the shaft of a bone. The arrows indicate the direction of the force. It will be seen that the layers most peripherally placed will give first. This may very well explain the early incomplete cortical break seen by x-ray. The obliquity of the break may be explained by the arrangement of the trabecular system, which may influence the direction and appearance of the cortical break.

carbon dioxide tension, or by locally deficient oxidation.

Each time there occurs a "bowing" in a definite direction, there is a concomitant pull by the soft tissue structures on the periosteum on the contralateral side. Therefore, it would be the most likely area for the periosteal reaction to be at a maximum, particularly if one considers the possibility of a small amount of stripping of the periosteum from the bone as well. The "bending" strain on the bone would become exaggerated in direct proportion to the progressively increasing spasm of the over-exercised muscle group until the first evidence of a break in the cortex appears.

It will be remembered that emphasis was placed on the similarity in the cortical break as it appeared in the femur and metatarsal bone. A thin, wafer-like longitudinal section was made through the shaft of these round bones and then examined by means of transillumination. It immediately became evident that many longitudinal striations extended in the long axis of the cortex. This, in effect, produced a lamellation or lamination of the dense cortex. Obviously, the Haversian system has produced the effect of a static skeletal framework, which enjoys the tensile strength roughly analogous to the set of juxtaposed leaves of an automobile spring, if one can imagine the leaves as much more numerous and much thinner as they lie with their flat surfaces piled upon each other. It can readily be seen that if a force, which causes a bowing outward of this laminated system, continues to the point of fracture, it will be the outermost layers which are closest to the periphery which will burst or be "sprung" first. (Fig. 5A.) This would, in effect, cause a gaping of the peripheral layers of the cortex, leaving the more centripetally-placed layers bent but not broken. (Fig. 5B.) Of course one would have to see this in the early films only. In the pubis, these conditions could not obtain, due to the conformity of the bone. Therefore, one will

amount of mature callus on the same side in the later phases. This constancy of the site of periosteal proliferation must be more than coincidental. Camp and McCullough<sup>17</sup> made this observation after reviewing a large number of pseudofractures of various etiology, and stated that "a periosteal reaction is sometimes observed in the region of the defect, and in the curved bones, may be apparent only on the concave side." As to the reason for this, the writer can only vouchsafe a guess. Due to the mechanics described above, there is an "elastic bending" in a definite direction (depending upon the bone, and its muscle pull). "Bending" is allowed by local, sometimes minute, softening of the architecture of the bone, causing a preternatural elasticity at that point. Jaffe<sup>18</sup> presents a theory which is most apt, since it seems to corroborate the fact that muscle action and tissue metabolism result in the nutritional skeletal change. He states that an increased local acidity may result in the production of narrow zones of either complete or partial decalcification in the vicinity of blood vessels. This local acidity is caused by the production of lactic acid, disturbances in

never see a displacement here, since there is only one break in the pubic ring.

#### PHASES OF THE LESION

1. Nutritive changes, caused by hyperemia, manifested by:
  - (a) Zone of rarefaction with local weakening of architecture.
  - (b) Periosteal proliferation on contralateral side. This will often be the latent or asymptomatic stage.
2. Beginning break in the cortex, incomplete at first, complete later. If early periosteal proliferation occurs, there will be minimal fracture with no displacement of fragments. If very little periosteal response is present, complete fracture and frequent displacement of fragments will occur. This is the symptomatic stage of the lesion.
3. Healing of the lesion with formation of mature callus, the greater portion of which will form on the contralateral side. The writer believes that there are only two phases of this lesion. The period of local decalcification due to nutritional changes is the initial stage. The second stage is the beginning break in the peripheral portion of the cortical layers. What has been called the third phase for practical purposes is in reality not a phase at all but only a complication. I would like to emphasize again that what is seen as a line of absorption is really a pseudofracture, quite similar to that seen in other abnormal nutritive states, and would show no characteristic lesion at the site of the absorption. In other words, many so-called pseudofractures could have widely divergent origin, but the pathological condition at the site of "give" appears approximately the same on microscopic examination. March fracture is included in this group. With this particular problem in mind, efforts are being made, and a subsequent report will follow, concerning certain modifications in the shoes of the freshly inducted soldiers in order to obviate this condition in the metatarsal bone.

#### CONCLUSION\*

Due to the pathological disorder being essentially one of local inadequacy of metabolism, causing skeletal changes which render the bone more pliable, and therefore more prone to fracture, the writer wishes to present the term of "insufficiency fracture," as more representative of a lesion which involves bones other than the metatarsal. A plea is made for earlier diagnosis before fracture has occurred. It is only in this manner that the convalescence will be shortened and many man-hours of training consequently saved.

Acknowledgment is made to Colonel Albert Bowen, M. C., for his many helpful suggestions and for his co-operative and sympathetic attitude. Acknowledgement is also made to Major Dean Jones, M. C., for the generosity with which he provided the clinical material and his willingness to provide all the facilities available in the X-ray Department and the Department of Clinical Photography.

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\* Since the completion of this paper, the author has had occasion to study more than one hundred such insufficiency fractures and all the observations which were made in the above short series have been found to hold true. To recapitulate, those cases which exhibited early periosteal proliferation did not fracture; those which did not exhibit early periosteal proliferation fractured, probably due to the absence of this periosteal buttress. Those that did fracture always demonstrated displacement of the distal fragment laterally, indicating the presence of a definite force in a constant direction. He again wishes to emphasize that insufficiency fracture is, in its early stages, a pseudofracture, which should be included in the same group as those pseudofractures caused by other nutritional states.

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No injured person should be moved until his wound has been dressed and the fracture has been immobilized securely. . . . Calmness and the avoidance of unnecessary haste are important, and rough and unnecessary handling should be avoided.

From "Fractures and Dislocations for Practitioners" by Edwin O. Geckeler (Williams & Wilkins Company).

# THE TREATMENT OF TRAUMATIC BURSITIS BY INTERNAL PARACENTESIS

ERNEST BURGESS, M.D.

Chief-of-Staff, Northern Permanente Foundation

VANCOUVER, WASHINGTON

**C**ONSERVATIVE treatment of traumatic bursitis has not been entirely satisfactory. This is especially true of those superficial bursas in areas constantly exposed to trauma, examples of which are the prepatellar, olecranon and malleolar bursas.

It may well be argued that failure of conservative treatment, particularly in acute bursitis resulting from a single direct trauma, lies in lack of diligence, i.e., insufficient immobilization, inadequate protection from subsequent injury and lack of sustained pressure over the area. This may well be the case. Nevertheless, the fact exists that many of these cases do not respond to accepted measures of treatment. While the actual disability may often be slight, chronicity of effusion and mild discomfort persist and eventually radical excision is necessary.

Two types of traumatic bursitis are commonly seen: The first is an acute hemorrhagic form resulting from a sudden direct contusion. The second type is a chronic transudative bursitis brought on by repeated minor injuries. The life history of each type differs, although at certain stages the physical findings of the two types may be almost identical.

In the acute form, the patient falls or forcibly strikes the bursal area, precipitating bleeding and an acute, nonsuppurative inflammatory process involving both the synovium and the adjacent tissues. The area is tender, hot, swollen and discolored. The bursal sac is distended with a mixture of blood and bursal fluid.

It is a generally accepted practice in these cases to aspirate the contents and apply a pressure immobilizing dressing over

the area. More zealous surgeons may splint the part with plaster. In either event the acute reaction subsides over a period of ten to fourteen days and in a certain percentage of cases complete recovery progressively follows. With many of these patients, however, the outcome is not so successful. Despite resolution of the inflammatory process in the surrounding tissues, the bursa remains somewhat tender and the effusion persists. Repeated aspiration and pressure dressings fail to overcome this effusion. A chronic hypertrophic synovitis develops. Shortly, bits of fibrin, villous tags, cellular débris and transudate protein coagulate and coalesce to form firm fibrinous "rice" bodies which can be easily felt by both physician and patient, and form a further source of irritation. An irreversible pathological process now exists which requires surgical excision to cure.

Chronic traumatic bursitis is caused by a repeated low-grade, mechanical irritation. It develops slowly and painlessly. Unaccustomed and functionally unadapted to such trauma, the bursa and the surrounding soft parts gradually thicken. A "cold" bursal synovitis develops. Moderate, non-hemorrhagic effusion appears and persists although the sac is rarely tense with fluid. Fibrinous bodies form similar to those described. Often they progress to degenerative calcification. Synovial xanthomatosis may ensue. The patient complains of disfigurement rather than discomfort. Housemaid's or floorlayer's knee is the classical example of this condition.

Conservative treatment is even less successful in these chronic cases. Occasionally, the usual measures together with a change of occupation or complete pro-

longed protection will reduce the effusion and tissue thickening. More often, no significant result is obtained. Again, exci-

diathesis. The author believes the disturbance is primarily local, and in most cases mechanical.

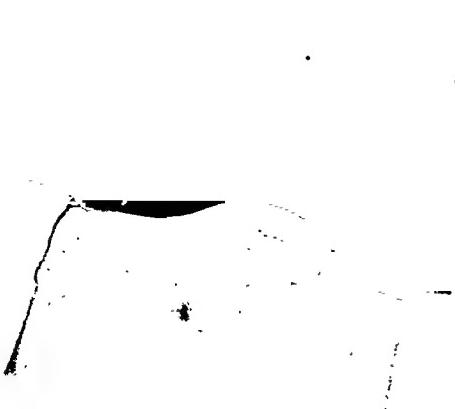


FIG. 1. Traumatic prepatellar bursitis, two months' duration. Repeated aspirations and pressure dressings have been unsuccessful in controlling the effusion.



FIG. 2. Local procaine anesthesia preliminary to internal paracentesis.

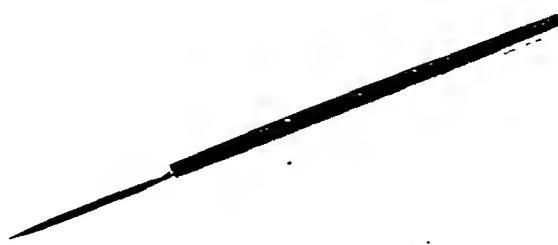


FIG. 3. Cataract knife used to carry out operative procedure.

sion of the bursa is usually considered the only adequate treatment.

Injection of sclerosing and scar-provoking solutions is practiced by some surgeons. This method has not gained widespread usage. In the author's hands it has too often merely aggravated the inflammatory process for a time without obliterating the bursal sac.

The failure of conservative treatment in these cases is frequently attributed to underlying systemic disorder such as a focus of infection elsewhere or a rheumatoid

Normal bursas are mechanical structures placed to minimize friction between contiguous tissue moving on each other. They are neither anatomically designed nor placed to withstand continued external pressure, nor to pad or protect bony prominences. Thus one does not see them placed superficially in pressure areas such as the palms or soles.

When, as a result of man's posture and occupation, a superficially placed bursa is traumatized, the pathological processes described logically follow. Once a bursa has

become traumatized and inflamed, repeated trauma, often occupationally unavoidable, keeps up the process. Soon the sac lining is

## TECHNIC

*Olecranon Bursa.* The area is thoroughly prepared surgically and draped.



FIG. 4. The knife has been introduced through the anesthetized skin into the bursal sac. With a circular movement, a wide incision is made through the superior portion of the bursa into the subcutaneous tissues.

scarred and osmotic relations are altered so that it is mechanically impossible for resolution to take place by conservative means without extended treatment, time loss or change of occupation.

Confronted with many of these cases among shipbuilders, the author has utilized a simple, semiconservative, mechanical procedure, actually an internal paracentesis or bursotomy, which has proved of considerable value and entails no time loss. The operation consists of creating a wide communication between the bursal sac and the adjacent subcutaneous tissues. This is accomplished by passing a thin, long cataract knife into the bursa from without, then cutting a wide semicircular opening through the bursal wall into the adjacent subcutaneous tissues. The bursal fluid disperses through the opening and is absorbed. The patient uses the part freely and the communication permits continued fluid absorption until the process quiets down and signs and symptoms disappear.

FIG. 5. Immediate postoperative picture. Most of the bursal fluid has been forced through the new internal communication and now can be seen distending the subcutaneous tissues proximal to the bursa. Absorption can now take place. A small dressing is placed over the site of incision and the patient may return at once to his usual activities.

With the elbow flexed, a skin area one-third of the distance from the distal bursal margin and directly over the center of the bursa is anesthetized with a few drops of novocaine. Five to 10 cc. of the procaine are then inserted directly into the bursal sac. The cataract knife is thrust directly through the anesthetized area into the bursal cavity. The knife is then tilted distally and with a semicircular motion, the entire distal bursal sac is incised into the adjacent subcutaneous tissues of the forearm. The knife is withdrawn and the bursal fluid forced through the internal communication down into the forearm. A sterile dressing is applied over the knife wound and the patient returns to work. The entire operation takes five to ten minutes. The patient is instructed to use the arm freely. There is little pain associated with the procedure since the internal-bursal procaine anesthetized the lining of the sac. For the prepatellar bursa the intrabursal incision is made through the superior portion, care

being taken not to enter the suprapatellar pouch of the knee joint. The olecranon and prepatellar bursas have been the only two

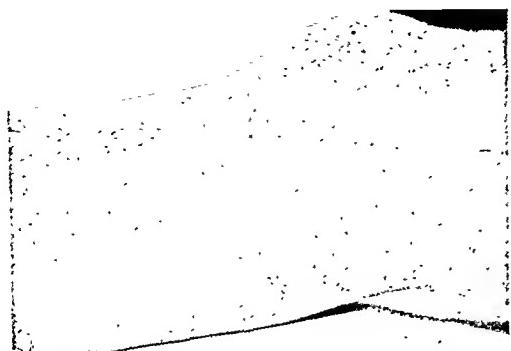


FIG. 6. Same knee as previously illustrated, ten days after internal paracentesis. The effusion has not recurred and the knee is symptom free and normal in appearance. Slight thickening of the bursal wall is still present.

on which I have carried out internal paracentesis to date.

Fourteen cases of traumatic bursitis have been treated using this method. Eight involved the olecranon bursa and six the prepatellar bursa. All have gone on to complete recovery without complication. In two of the cases the original operation was inadequate, the communication closed prematurely, and it was necessary to repeat the procedure. No time loss ensued other than that necessary to perform the operation and for after-care visits which averaged two in this series. In some of the cases a change of occupation was advised where continued exposure could not be avoided, or the patient was advised to use a protective pad at work.

It is important that the part not be splinted after internal paracentesis. The motion tends to keep the communication

open and the bursa empty. Other than that, no other special postoperative routine is necessary. Surgical cleanliness in redressing is axiomatic. None of the patients required postoperative analgesia and there were no complaints of continued pain or tenderness.

This simple operation is not a panacea for chronic bursitis. It has a definite field of usefulness, namely, in subacute and chronic traumatic bursitis without significant rice-body formation. It should not be used in the acute hemorrhagic cases. Aspiration and the usual routine are there indicated. The time to perform internal paracentesis is after the acute reaction has subsided and when it is apparent that a rapid disappearance of the effusion is not forthcoming. It should *never* be used when there is indication of any infectious process or neoplasm.

Although the author has utilized this technic in two locations only, there is no reason why it could not be applied elsewhere, nor why it cannot be modified to assist in curing other similar chronic enclosed and encapsulated fluid masses such as chronic encapsulated hematomas and cysts, the contents of which are innocuous to the adjacent tissues and the general circulation.

#### SUMMARY

A technic is proposed whereby the effusion and other signs and symptoms of subacute and chronic traumatic bursitis can be relieved. The operation consists of a simple paracentesis and internal bursotomy of the bursal sac creating a new communication between the sac and the adjacent subcutaneous tissues.

The technic is simple, without significant danger and involves no time loss or disability for workmen. It has been used successfully in fourteen cases of traumatic prepatellar and olecranon bursitis.



# SIMPLE DRAINAGE OF INTRATHORACIC SUPPURATIONS\*

## USE OF AN ENDOCUTANEOUS (ELOESSER) FLAP

LIEUT. COMDR. A. LINCOLN BROWN, M.C. U.S.N.R.  
SAN FRANCISCO, CALIFORNIA

THE value of any method for the treatment of intrathoracic suppurations which requires essentially no after care is obvious at any time. This is particularly true both under the stress of civil or military medicine as during the present emergency. The cases upon which the present study is based come entirely from civil practice. But this should in no way detract from the value of the procedure in the military service where, I believe, it would be unusually suitable.

In 1935, Eloesser<sup>1</sup> described an operation for secondarily infected tuberculous empyemas evolved through desire to obviate the continuous use of a drainage tube. The operation consisted of forming a finger-like flap of skin which was inserted through a thoracotomy wound into the pleura. A tract was thus formed into the empyema cavity which, because of the presence of skin on one side and fascial structures on the other, remained open and required no attention other than dressings. This same flap produced a valve-like mechanism whereby material such as pus and air readily escaped from the empyema space but which acted to prevent the entrance of atmospheric air. Thereby a tendency to develop a negative pressure in the empyema space resulted and expansion of the lung and obliteration of the dead space was favored. This procedure appealed to us sufficiently to suggest its use in cases similar to those reported by Eloesser. The results in these particular cases were sufficiently satisfactory to encourage its use in other intrathoracic fluid accumula-

tions. Fifty-four instances (Chart 1) in which this procedure has been employed by us are analyzed so that the relative value of this technic in various conditions may be evaluated.

### OPERATIVE TECHNIC

The technic is simple. It is carried out uniformly under local anesthesia and usually consists of both field block and intercostal nerve block. The position of the patient on the table is essentially that used for the introduction of an artificial pneumothorax. A site near the most dependent position of the cavity to be drained is selected and when feasible the base of the flap is placed parallel with the line of the ribs. (Fig. 1.) A full thickness skin flap is fashioned. The total length of the flap is about 12 cm. and tapers somewhat so that the width of the base usually measures 6 cm. in width while the width near the tip is about 4 cm. The flap is so fashioned that subsequent movements of the shoulder girdle will have the least tendency to pull thereon.

At the same time the flap is fashioned any previously existing scar or sinus tract is excised. Thus an old thoracotomy scar may be used as one border of the flap. (Fig. 2.) It is inadvisable to include scar tissue in the flap for should this scar traverse the flap it materially interferes with circulation and nutrition. A section of rib about 3 or 4 cm. in length, with the underlying thickened pleura, is removed in sufficient amount to allow the easy introduction of the tip of the flap as well as a

\* From the Dept. of Surgery, Division of Thoracic Surgery, University of California Medical School, and the San Francisco Department of Public Health, San Francisco City and County Hospital and is being published with the further authority of Capt. E. E. Curtis, M.C., U.S.N. Ret., C.O. U.S. Naval Dispensary, Treasure Island.

The opinions expressed in this article are entirely those of the author and no approval or disapproval by the Medical Department of the U.S. Navy is implied.

## CHART I

Name	Age	Sex	Diagnosis	Type of Empyema	Organism	Bron-cho-pleural fistula
SS	27	M	Pulmonary Tuberculosis Mixed Empyema, right	Mixed	Strep. TB	+
BM	28	M	TB Spine (T-5, 6, 7, 8, 9, 10) ParaVertebral Abscess Empyema Psoas Abscess	TB Empyema following Hibbs-Albee fusion	-	-
AG	60	F	Lung Embolus with empy- ema right Thrombophlebitis, leg	Chronic empyema, right	Gram-positive cocci	-
VL	34	M	Mixed TB Empyema, right	Mixed empyema	TB B. Coli Strep. Viridans	+
AT	48	M	Bronchogenic Carcinoma, right	Empyema following pneumonectomy	-	+
JP	34	M	Pulmonary TB, far ad- vanced, bilateral Mixed empyema, left	Mixed empyema fol- lowing a spontaneous pneumothorax	TB Strep.	+
EW	37	F	Pulmonary TB, far ad- vanced Mixed empyema (TB), left Erysipelas, left thorax	Mixed TB empyema	TB	-
STW	20	M	Angio-sarcoma Empyema, left following pneumonectomy	Mixed empyema	Strep. M. Catarrhalis B. Welchii	+
CR	47	M	Bronchial adenoma Left empyema following pneumonectomy	Empyema, left	Strep. hemolytic	+
TR	27	M	Post-pneumonic empyema, secondarily infected with TB	Mixed TB empyema (3 years duration)	TB Other?	-
NC	25	M	Pulmonary TB Tuberculous empyema, right	Mixed TB empyema	TB Staph. (aureus) H. Strep. B. (II)	-



November, 1943

## CHART I (Continued)

## Results of Flap Operation

Amount of Drainage and Dressing Required Ultimately	Flap Used	Secondary Operation Needed	Closure of Sinus	Later Course	Other Therapy
20-30 cc. daily 1 dressing daily	+	No	No		
200-300 cc. daily 2-3 dressings daily	+	No	No		Oticothorax 12-22-32 Phrenic Atrophy 5-27-33 Thoracoplasty 1-11 ribs '33
30-40 cc. daily	+	No			None
			Tissue graft		None
30 cc. daily (3 mo. later) 1 dressing daily	+	No	Yes		
1 dressing daily	+	No			None
5 cc. daily 1 dressing daily	+	No	No - monthly		None
					2 stage thoracoplasty
		Second operation No	Still draining		2 stage thoracoplasty
		3-17-37			1-10 ribs
1 dressing daily	+	Mazingo tube 9-16-38	Yes (empyema still present)	Yes (empyema pres. ent)	Pneumonectomy 11-20-37
1 dressing daily	+	No	No	Satisfactory drain- age	Pneumonectomy 12-14-38
20-30 cc. pus daily 1-2 dressings daily	+	No	No	Satisfactory drain- age	None

CHART I (*Continued*)

Name	Age	Sex	Diagnosis	Type of Empyema	Organism	Bronchopleural Fistula
MB	27	F	TB Empyema	TB Empyema	Pathological report TB	—
FZ	33	M	Postpneumonic empyema, left	Postpneumonic empyema	Strep. (Viridans) Staph. (albus)	+
WT	63	M	Chronic pneumonococcic empyema, right	Pneumococcic empyema, right (chronic)	Pneumococcus Type III	—
BJ	6	F	Chronic empyema, right	Chronic empyema	Strep. (Viridans) Staph. (aureus) B. Proteus Diphtheroids	+
OT	36	M	Pulmonary TB, healed TB empyema	Chronic TB empyema	TB	—
AL	25	F	Pulmonary TB TB empyema	TB empyema	TB	—
JD	36	M	Pulmonary TB	Mixed TB empyema	TB Staph. (albus)	+
JE	41	M	Cystic Disease of lung	Empyema following tube	Staph. (albus), right Staph. (aureus), right	+
PC	58	M	Pulmonary TB TB empyema	TB Empyema	TB	+
RT	28	M	Pulmonary TB Mixed TB empyema	Mixed TB empyema	TB Staph. (albus) B. Strep. B. Influenza	?
SB	43	F	Pulmonary TB, far advanced, bilateral, cavity	Empyema, left (mixed TB)	TB Staph. (aureus) Diphtheroid B.	+

*CHART I (Continued)*

CHART I (*Continued*)

Results of Flap Operation					Other Therapy
Amount of Drainage and Dressing Required Ultimately	Flap Held	Secondary Operation Needed	Closure of Sinus	Later Course	
2-3 drops drainage	+	No	No	Satisfactory	
Few drops of pus 1 dressing daily	+	No	No	Satisfactory	Thoracoplasty 8-13-38 Muscle plastic 8-13-38 Muscle plastic 8-25-39
1 dressing daily	+	Yes (revision on 3-30-40)	1st almost closed	Satisfactory	
Slight amount of drainage 1 dressing daily	+	No	No	Satisfactory	None
1 dressing daily	+	Yes (increased size flap 11-19-41)	No	Satisfactory	5-7-42 Thoracoplasty
1 dressing daily	+	Yes	No	Not draining well	
1 dressing daily	+	No	?	Satisfactory	1st stage thoracoplasty 9-27-37 2d stage 10-19-37 Phrenic crush 1-21-38
1 dressing as needed	+	No	No	Satisfactory	
Drainage profuse 3-4 dressings daily	+	No	No	Patient expired	None
1 dressing daily	+	Robert's operation 9-13-37 and 9-24-37 Shede 1st 5-25-38 2d 9-14-38	No	Satisfactory	Thoracoplasty 1st 1-4 ribs 5-17-37 2d—5-7 ribs 6-4-37 Sinus revision 7-30-37 Pineh graft 7-5-40
1 dressing daily	+	No	No		

## CHART I (Continued)

Name	Age	Sex	Diagnosis	Type of Empyema	Organism	Bron-cho-pleural Fistula
MM	21	F	Mixed TB empyema, right Epilepsy	Mixed TB empyema	d. Strep. Guinea Pig +	+
JA	39	M	Pulmonary TB, far ad- vanced Diabetes Mellitus (Lung absecess on entry)	Cavity drainage, not empyema	Gumma. Strep. Staph. (aureus) TB	+
BZ	37	M	Pulmonary TB, far ad- vanced Empyema, left	Mixed TB empyema	TB Anaerobic Strep.	-
JO'M	47	M	Mixed TB empyema Baeteremia (staph.)	Mixed TB empyema	B. Strep. TB (Guinea pig)	-
AT	57	M	Lung absecess Chronic empyema	Chronic putrid empy- ema	Anaerobic Strep. Fusiform B.	+
HO	47	M	Chronic empyema (pneumo- cocci) Atonic bladder	Chronic empyema	Pneumococci Type I	-
MD	28	F	Postabortion pelvic absecess and thrombophlebitis Postabortion septicemia Broncho-pneumonia Pulmonary embolism Baeterial endocarditis	Putrid empyema (acute)	Staph. Strep. Diplococci	-
AT	43	M	Diphtheria Broncho-pneumonia Empyema Peritonitis	Empyema, strep., fol- lowing pneumonia (chronic)	d. Strep.	-
EA	25	F	Bronchial adenoma Lobectomy Empyema necessitans fol- lowing operation	Empyema following lobectomy	Nonhemolytic staph. (albus)	+
MK	31	F	Pulmonary TB, left Lobectomy Empyema (staph.) & TB	Empyema following lobectomy (partial)	Nonhemolytic staph. (albus) TB (5-3-42)	+
RC	36	F	Chronie TB Empyema (mixed) 18 years	Mixed TB empyema (draining sinus)	Staph. (aureus) hemolytic	-

CHART I (*Continued*)

Previous Drainage and Results	Eloesser Flap	Course—Drainage (Temperature, Pulse, General Condition)					Results of Flap Operation			
		Imme- di- ate Im- prove- ment	Im- prove- ment Within 1 Week	Im- prove- ment Within 2 Weeks	Ulti- mate Im- prove- ment	No Im- prove- ment	Un- changed	Smaller	Closed	Bron- cho- pleural Fistula Closed
Tube 9-4-38 to 10-31-38	10-31-38				+			+		+
Open drainage of cavity 4-11-38 to 11-29-39 Sinus revision 9-15-39	11-29-39	+								—
Tube 10-31-39 to 7-31-40—9 months	7-31-40					—		+		None
None	9-25-40			+				+		None
Nov.-Dec. 1939, Inadequate Rib resection 6-24-40 Inadequate	10-10-40				+		—			—
None	11-6-40				+					None
None	11-16-40					—	—			None
Tube 12-7-40 to 12-13-40 Inadequate drainage	12-13-40				+		—			None
Wound open and drained 4-30-41	5-9-41	+					—			—
None	3-4-41	+						+		None
?	2-1-41			+				+		None

CHART I (*Continued*)

Results of Flap Operation					Other Therapy
Amount of Drainage and Dressing Required Ultimately	Flap Held	Secondary Operation Needed	Closure of Sinus	Later Course	
1 dressing daily	+	Abseess formed in flap wound drained twice (2 yrs. later)	No	Satisfactory except for abseess	
1 dressing daily	+	No	No	Satisfactory	Musele flap operation 8-10-38
1 dressing daily	+	No	No	Flap not working as valve	None
1 dressing every 4 days	+	No	No	Satisfactory	None
1 dressing every 2 days	+	No	No	Satisfactory	None
1 dressing daily	+	No	No	Satisfactory	None
2-3 dressings daily	+	No	No		
2-3 dressings daily	+	No	No	Satisfactory	None
10-15 cc. daily 1 dressing daily	+	No	No	Gradual improvement with less drainage and weight gain	Lobectomy 2-26-41
20 cc. daily 1 dressing daily	+	No	No	Improving with cavity closing and less drainage	Lobectomy for possible tumor 12-30-40 Plastic repair 1-9-42
1 dressing daily	+	No	No	Satisfactory	None

CHART I (*Continued*)

Name	Age	Sex	Diagnosis	Type of Empyema	Organism	Bron- eho- pleural Fistula
LP	50	M	Silicosis Empyema	Empyema	Gram-neg. rods Anaerobic gram-neg. rods	+
TB		M	Pulmonary TB Mixed empyema	TB cavity drained	TB	-
RDS and 9 cases similar	19	F	Pulmonary TB with tension cavity (+12)	TB cavity drained	TB	+
OT	34	M	Mixed TB empyema	Occurred early in course of pneumo- thorax treatment	TB Mixed	-
GP	57	M	Mixed TB empyema	Advanced bilateral pulmonary TB	TB Mixed	-
HS	25	M	Chronic empyema	Chronic empyema	Anaerobic nonhemolytic strep. Anaerobic hemolytic staph.	+
JH	33	F	Pulmonary TB TB empyema	TB empyema	TB (?)	+
JPH	19	M	Echinococcic cyst	Followed removal of cyst	No growth	+
RB	17 mo	M	Interlobar empyema follow- ing pneumonia	Pneumococcic empy- ema	Pneumococcus (type I)	+
SS	18	M	Pulmonary TB, rt. ? TB extrapleural empy- ema	Followed extrapleural Mixed empyema	TB Staph. Strep. Diphtheroids	+
RW	23	M	General mixed empyema	Mixed empyema	Strep (Viridans) Proteus vulgaris Anaerobic diphtheroids	+
HW	35	M	Pulmonary TB	TB cavity drained	TB	?

CHART I (*Continued*)

Previous Drainage and Results	Eloesser Flap	Course—Drainage (Temperature, Pulse, General Condition)					Results of Flap Operation			
		Imme-diate Im-prove-ment	Im-prove-ment Within 1 Week	Im-prove-ment Within 2 Weeks	Ulti-mate Im-prove-ment	No Im-prove-ment	Un-changed	Smaller	Closed	Bron-chio-pleural Fistula Closed
None	1-13-39		+					+		None
None	7-18-38	+								None
None	9-27-40				+				+	None
None	6-12-40	+						-		None
None	6-4-41	+						-		None
None	12-10-40	+						-		+
None	10-18-41 10-20-41	+						+		+
None								+		+
Closed thoracotomy 6-1-42	1-26-42 6-9-42	+						+		None
None except thora-centesis	6-4-42 6-26-42	+						+		-
Tube drainage prior to Jan 1942	1-22-42	-					Ex-pired			None
None	6-15-42	+		Too soon						None

CHART I (*Continued*)

## Results of Flap Operation

Amount of Drainage and Dressing Required Ultimately	Flap Held	Secondary Operation Needed	Closure of Sinus	Other Therapy	
				Later Course	
Few drops daily (10-17-39) 1-13-41 increased drainage	+	No	No	Satisfactory	None
1 dressing daily	+	Yes 9-10-38	No	Satisfactory	None
Closed on discharge	+	No	Yes	Satisfactory Negative sputum and drainage 1 mo. post-op.	Pneumothorax left, Nov. 38 Extra-pleural 2-3-30 1st stage thoracoplasty 10-22-30 2d stage 1-18-40
1 dressing daily	-	Yes	Too early	Too early	Flap revision
2-3 dressings daily	+	No	Too early	Too early	None
1 dressing daily	+	No	No	Satisfactory	None
2 dressings daily	+	No	No	Satisfactory	None
None	+	No	No	Satisfactory	Thoracotomy for re- moval of echinococcal cyst 1-5-42
?	+	No	Too early	Satisfactory	
2 dressings daily	+	No	No	Satisfactory	None
1 dressing daily	+	Yes Revision 3-22-42 Open thoracot- omy 5-8-42	No	Developed purulent meningitis 5 days after thoracotomy; expired	
1 dressing daily	+	Yes 2nd stage flap operation	Too early	Too early	Too early

sufficient opening for drainage after the flap is in place. This opening is placed approximately under the center of the

will be found to be the proper size in a short space of time. No tubes are inserted.

It will now be found that in most in-

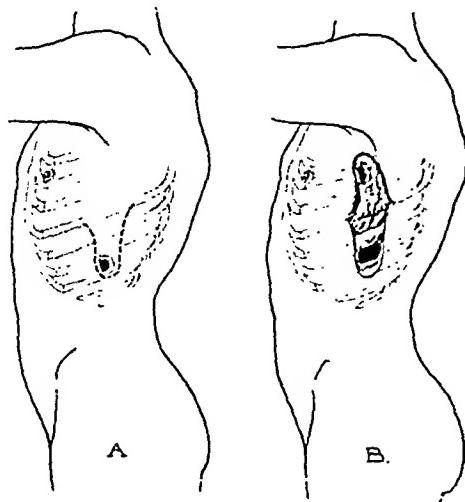


FIG. 1. Diagram illustrating usual site of flap and approximate length of rib removed.

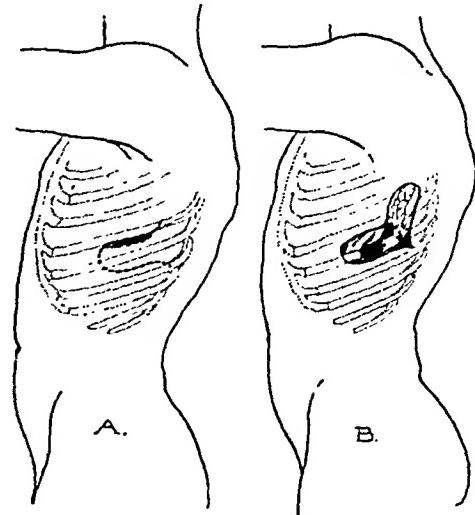


FIG. 2. Variation in direction and site of flap as might be indicated where an old thoracotomy scar may be used as one border of flap.

length of the flap, thus allowing adequate flap tissue to be turned in without tension. The pleural space and lung are now inspected, all secretions being aspirated and removed from the pleural space. Before the flap is fastened the tip is denuded of excess fat tissue. The flap is treated gently and very little attention is paid to complete hemostasis as it is believed complete hemostasis might jeopardize the viability of the flap. A transfixation suture of No. 1 chromic catgut anchors the flap to the parietal pleura. (Fig. 3.) The wound edges are now approximated with nonabsorbable skin sutures as shown in Figure 4, care being taken not to close the wound too completely as this would tend to seal off the opening. Here it must be remembered that while the flap is being fashioned the side of the chest and arm are in extension. The opening will appear larger in this position than when the arm is again placed at the patient's side and the segment of thoracic wall is allowed to drop down. There is a tendency for the skin portion of the opening to contract during the early days and weeks. If one bears this in mind, an opening which at first seems too large

stances an opening has been produced which allows for egress of material from the cavity but which on the other hand tends to have a valve-like action which prevents the entrance of air. Thus, there is a tendency to keep the cavity empty of contained secretions, but at the same time a negative pressure is usually developed which aids in the re-expansion of the underlying lung. On rare occasions this negative pressure is so great that the patient is inconvenienced thereby. When this occurs he is taught to use a small catheter which can be inserted into the opening. This relieves the valve action and allows the entrance of air, thereby bringing the intrapleural pressure to neutral. A vaseline gauze dressing is placed over the wound and ABD pads applied. These are changed as frequently as the drainage necessitates. As the amount of drainage decreases a few layers of gauze are substituted for the pads. A simple jacket<sup>2</sup> containing an oiled silk pocket to hold the gauze directly over the wound is often supplied the patient. This jacket obviates the continual use of adhesive. The skin sutures must be left until they almost

slough out as obviously the wound cannot fail to be infected by the drainage which flows over the raw surface; but, because of this free drainage, the ultimate healing of the wound readily takes place in about ten days without further interference. However, a few instances have presented themselves in which the opening has contracted sufficiently in subsequent weeks to warrant a simple enlargement thereof.

Naturally this procedure does not of itself necessitate the patient's remaining in bed.

#### INDICATIONS

The flap operation was performed on fifty-four patients. (Table I.) In twenty-nine instances this was the first type of

TABLE I Flap Operation Performed for:	
Mixed Tuberculous Empyema.....	17
With bronchopleural fistula.....	8
Without bronchopleural fistula.....	8
With probable bronchopleural fistula.....	1
Tuberculous Empyema (drainage because of marked toxicity).....	6
With bronchopleural fistula.....	2
Direct Tuberculous Cavity Drainage.....	12
With fistula.....	1
Nontuberculous Empyema Drainage.....	16*
With bronchial fistula.....	8
Cystic Disease of Lung.....	1
Silicosis plus Bronchopleural Fistula and Empyema.....	1
Echinococcal Cyst.....	1

TABLE II Flap Was Used as Primary Drainage Operation	
Mixed tuberculous empyema.....	7
Direct drainage of tuberculous cavity.....	12
Simple tuberculous empyema.....	3
Chronic empyema (nontuberculous).....	2

Flap Used Secondarily (after other drainage unsatisfactory).....	
Mixed tuberculous empyema.....	9
Chronic empyema (nontuberculous).....	12
Simple tuberculous empyema.....	3
(1 mixed tuberculous empyema—previous drainage unknown)	

- \* (1 Postpulmonary embolus
- 1 Postpneumonectomy for cancer
- 1 Postpneumonectomy for angio-sarcoma
- 1 Postpneumonectomy for bronchial adenoma
- 1 Postpneumonectomy for pulmonary tuberculosis
- 8 Postpneumonococcal pneumonia (with fistula 2)
- 1 Postrupture lung abscess
- 1 Postabortion thrombophlebitis and septicemia
- 1 Pleurisy accompanied by general mixed empyema<sup>1</sup>

surgical drainage to which the patient had been submitted (other than possible thoracentesis) (Table II.) Twenty-four

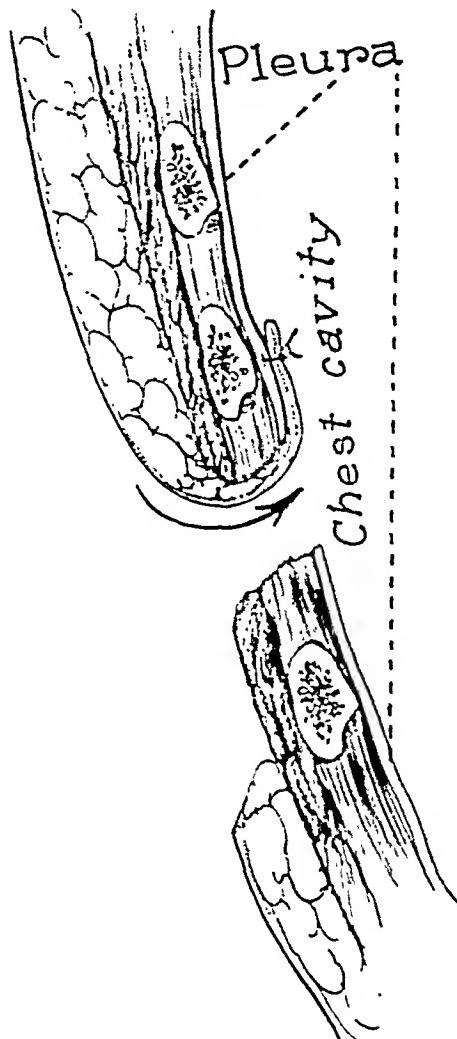


FIG. 3. Diagram illustrating fixation suture which holds the flap in contact with the parietal pleura. It is to be noted that the subcutaneous tissue and fat have been gradually tapered off the distal end of the flap.

patients received the flap operation after other forms of surgical drainage (tubes, rib resections) had previously been found wanting over a period of months or even years. The history of one patient who received the flap operation is incomplete insofar as the record of any previous treatment is concerned.

#### RESULTS

Of the fifty-four patients operated upon forty-six improved sooner or later by

operation and eight were not benefited by it. Of those not benefited, one expired within twenty-four hours after operation.

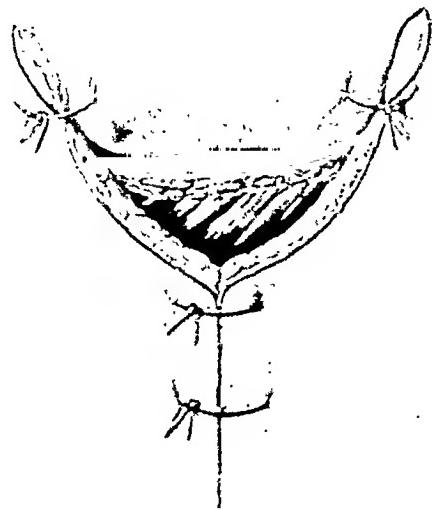


FIG. 4. Reproduction representation of the method of closure and the appearance of the wound at the termination of the closure.

It must be admitted that he was practically moribund when drainage was instituted. Another which had had a flap several months previously that had not functioned well expired about six days following a radical thoracotomy from a metastatic purulent meningitis. This patient had a tremendous amount of necrotic material

in a very extensive empyema cavity. The other six were at least not harmed by the operative procedure.

The empyema cavity changed for the better, that is, became smaller in twenty-nine cases of which eleven showed complete obliteration thereof. Of the cases having a bronchopleural fistula at the time of operation this closed completely in ten cases. The flap has held in all but two instances. Secondary operations were ultimately performed to aid the status of the patient further in ten instances.

#### CONCLUSIONS

The flap operation appears to be of definite value in the treatment of various types of intrathoracic collections of inflammatory material. This appears to be particularly true when previous drainage operations have been of no avail. Although, as can be seen from the reports, the primary use of the flap, especially in mixed tuberculous empyema and for direct drainage of tuberculous cavities, is often indicated and is a satisfactory measure.

The advantage of any method for the drainage of intrathoracic suppurations, such as the endocutaneous flap possesses, would be peculiarly applicable to such conditions under war time situations. This procedure has proved suitable in fifty-four patients whose ages varied from seventeen months to sixty-three years.

TABLE III  
RÉSUMÉ OF OPERATIVE RESULTS (SEE CHART I) OBTAINED  
IN EACH INDIVIDUAL CASE

Immediate improvement.....	20
Improvement in one week.....	4
Improvement in two weeks.....	3
Ultimate improvement.....	19
No improvement.....	8
Empyema cavity unchanged.....	20
Empyema cavity smaller.....	18
Empyema cavity closed.....	11
Bronchopleural fistula closed.....	12
Flap held.....	52
Secondary operation needed.....	10
Sinus closed.....	3
Yes	52
No	2
Yes	44
No	44

Appreciation is extended to Dr. Sidney Shipman for permission to include nine cases of primary drainage of tuberculous cavities and to Dr. Kazumi Kasuga for his efforts in the collection of statistical data included herein.

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# THE EFFECT OF ORCHIDECTOMY AND STILBESTROL IN CARCINOMA OF THE PROSTATE\*

CHARLES C. HERGER, M.D.

Urologist, State Institute for the Study  
of Malignant Diseases

AND

HANS R. SAUER, M.D.

Assistant Urologist, State Institute for the Study  
of Malignant Diseases

BUFFALO, NEW YORK

TREATMENT of inoperable carcinoma of the prostate with external or interstitial radiation as well as suprapubic cystostomy or transurethral resection has not yielded satisfactory end results in the majority of cases. It is obvious, therefore, that much attention has been created by recent reports in the literature which indicate that marked improvement in the condition of patients with carcinoma of the prostate can be accomplished by the administration of estrogen or by bilateral orchidectomy or both.

The existence of an interrelationship between testicular function and prostate was observed by numerous authors of the nineteenth century. As early as 1836 and 1837, D'Etoile and Civiale mentioned complete disappearance of the prostate in patients who had undergone bilateral orchidectomy for the treatment of double hernia. Marked atrophy of the prostate following castration was described also by Gruber (1847), Billharz (1859) and Pelican (1875). Grislith, in 1889, reported complete degeneration of the prostate in four castrated animals (two dogs, two cats). The first systematic experimental study as to the effect of castration on the prostate gland was carried out by White (1893) who reported that castration of thirty-five dogs invariably yielded atrophy of glandular and muscular elements of the prostate. These changes coincided with reduction in bulk and weight of the organ. The results of these experiments and White's suggestion to carry out castration for the treatment of adenoma of the prostate were responsible

at this time for an era of castration treatment for hypertrophy of the prostate. Three years later (1896) the subject was thoroughly discussed by Cabot at the meeting of the American Surgical Association. Cabot was able to collect 203 instances of castration carried out by various surgeons for the purpose of treating adenoma of the prostate. In an analysis of sixty-one cases in whom sufficient follow-up data could be obtained, diminution in the size of the prostate followed castration in the majority of the patients as estimated by rectal examination and evidence of shortening of the urethra. As far as the functional results were concerned Cabot reported "substantial or very great improvement" in 83.6 per cent and "moderate improvement" in 6.6 per cent of the patients treated. Complete failure was observed in only 9.8 per cent of the cases. In spite of these optimistic statements Cabot's paper contained also a note of caution. He emphasized that "if statistics are collected from reported cases, figures presented may be too favorable from the natural inclination to report successes, and from the tendency to put cases on record before sufficient time has elapsed for the determination of final effects of an operation."

In spite of this favorable report the end results were apparently unsatisfactory and castration as a method of treating adenoma of the prostate was abandoned a few years later.

The idea of eliminating testicular function as a means to influence overgrowth of

\* From the State Institute for the Study of Malignant Diseases, Buffalo, New York, Dr. Burton T. Simpson, Director.

prostatic tissue was revived by Strohm in 1935. He stated that female sex hormones act as a great boon to patients with carcinoma of the prostate. He reported also that injections of placental blood caused improvement in the patients' general condition and lessening of pain at the site of bone metastases. One year later (1936) Counsellor made the statement that pain due to metastases from carcinoma of the prostate subsides after administration of a sterilizing dose of  $\text{x}$ -radiation to the testes. This statement was made during a discussion at a Staff Meeting of the Mayo Clinic but it was not supported by the presentation of clinical material.

In 1940, Kahle and Maltby reported results of investigations dealing with the influence of stilbestrol in the treatment of fourteen patients with adenoma of the prostate. Marked improvement and relief from symptoms was accomplished in all of these fourteen patients. Improvement coincided with regression in size of the prostate, and microscopic examination of the prostatic tissue after treatment revealed reduction in the height and vacuolization of the cytoplasm of the epithelium as well as decrease of the papillary infoldings and decrease of the size of the organ (Schenken, Burns and Kahle).

The reports by Strohm, Counsellor and Kahle and Maltby were more or less neglected until 1941, at which time Huggins and collaborators reported spectacular results following castration of patients with carcinoma of the prostate. These authors stated that bilateral orchidectomy resulted in appreciable improvement in numerous cases of prostatic cancer even if demonstrable metastases to bones were present. This improvement coincided with gain in weight, increase in the red blood count and regression in size and softening of the consistency of the prostate. In addition, Huggins and his co-workers observed decrease of the serum acid phosphatase activity and increased osteosclerosis of bone metastases three to six months following castration. Favorable results were

obtained also if the patients received stilbestrol either alone or following orchidectomy. These reports have stimulated great interest in this subject and recent reports in the literature indicate that castration of patients with carcinoma of the prostate is now being carried out in numerous clinics.

Appreciable improvement of the patient's condition following orchidectomy or stilbestrol medication has been reported also by Higgins, Alyea and Henderson, Nesbit and Cummings, Gutman, Sullivan, Gutman and Gutman, Herbst, Chute, Willetts and Gens, Wishard, Kearns, Kahle and co-workers, etc. Improvement in the roentgenological appearance of bony metastases coinciding with decrease in serum acid phosphatase activity has been observed by numerous authors (Higgins, Nesbit and Cummings, Sullivan and Gutmanns, et al.).

Although the results reported up to the present time have been encouraging it is the consensus that clinical data have to be compiled over a longer period of time before the results of castration and stilbestrol treatment of carcinoma of the prostate can be evaluated properly.

During the past twelve months we have carried out castration and stilbestrol treatment or both in our patients with carcinoma of the prostate. In so doing we have followed the idea to employ castration singly or in combination with stilbestrol medication preferably on patients with demonstrable bone metastases. Exclusive stilbestrol medication was usually reserved for patients with no apparent evidence of metastatic spread. In addition, obstructive symptoms were treated by the usual methods such as indwelling catheter, suprapubic cystostomy or transurethral resection.

Ninety-four patients were subjected to treatment. Excluded from this report were twelve cases. In five of these twelve cases treatment was started too recently and seven patients did not return for follow-up examination. In the remaining eighty-two

patients, which form the basis for this report, the results of treatment were studied for a period of from three to twelve months.

The diagnosis of carcinoma of the prostate was confirmed by biopsy in seventy or 85.4 per cent of the eighty-two patients. In the remaining twelve cases repeated attempts to obtain a satisfactory biopsy were unsuccessful in nine instances and in three patients no biopsy was done for various reasons. In spite of that a diagnosis of prostatic cancer was made in these twelve cases from rectal and frequently cystoscopic examination. In all these patients the prostate was enlarged, indurated and nodular, and infiltration into the pelvis with involvement of the seminal vesicles was present.

No evidence of metastases at the time of writing was present in forty-seven or 57.3 per cent of the eighty-two cases of carcinoma of the prostate. Metastases were suspected from the clinical course in five patients (6.1 per cent), although metastatic bone lesions could not be demonstrated beyond doubt. The suspicion of metastatic bone involvement was based on a rapid downhill course of the patient accompanied by increasing pain in back and legs. Definite metastases were present in the remaining thirty (36.6 per cent) of the patients. In twenty-seven cases of this group metastatic bone changes were demonstrable in the x-ray picture while in three patients metastatic lymph node involvement was proved by microscopic examination.

Sixty of our eighty-two patients were subjected to stilbestrol medication alone. Ten patients of this group had metastases (eight to bones, two to lymph nodes), and metastatic bone lesions were suspected in five instances. No evidence of metastases was apparent in the remaining forty-five patients although local infiltration of the tumor beyond the capsule of the prostate had taken place in numerous cases.

Orchidectomy alone was carried out in three patients with demonstrable metastatic bone changes.

Castration either preceded or followed by stilbestrol medication was performed in the remaining nineteen patients. Seventeen cases of this group had metastases (sixteen to bones, one to lymph nodes) and no evidence of metastases was present in two patients.

In carrying out castration we have adopted Huggin's technic which consists of dissecting away the testicle from the epididymis followed by suture of tunica vaginalis and skin in layers. More recently we have performed orchidectomy through a midline incision into the scrotum. This procedure is time saving and reduces surgical trauma, an important factor in debilitated patients. No postoperative deaths have occurred in our series of cases.

It has been suggested by various authors (Wishard, Herbst, Alyea, Baker, Chute and collaborators, Kahle and Maltby, etc.) to begin stilbestrol medication with daily doses of 3 mg. and more, until evidence of effectiveness of the estrogen becomes apparent. In the opinion of these authors medication should then be either discontinued temporarily or reduced to a maintenance dose of 1 mg. daily.

In all our cases we have started stilbestrol medication with more conservative doses. One mg. was given orally as the initial daily dose and maintained unless an indication for decrease or increase of the dosage developed during the course of observation. The dose was decreased to 1 mg. every other day or twice weekly if the initial dosage was not tolerated for various reasons. On the other hand, the dose was increased to 2 or 3 mg. daily if we were not satisfied with the patients' response to treatment.

This procedure is in accordance with statements made by Young at the 1942 meeting of the American Urological Association. Young maintained that, in his opinion, the influence of androgen on the patient with carcinoma of the prostate can be controlled more permanently if small amounts of female sex hormone are administered continuously. This procedure,

according to Young, promises to be more effective than the intermittent administration of large and toxic doses of estrogen.

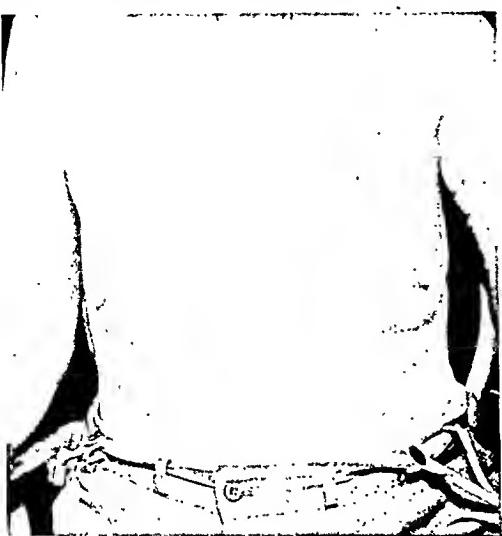


FIG. 1. A, E. B., seventy-three, Case No. 35678. Marked hypertrophy of breasts after oral administration of 154 mg. of stilbestrol (1 mg. daily).

Study of our results has convinced us that daily doses of 1 mg. of stilbestrol,

the direct and indirect effects on the primary lesion, side effects such as tenderness and enlargement of both nipples as well as hypertrophy of the breast tissue developed in numerous cases. (Fig. 1A and B.)

Breast changes were observed in thirty-three or 41.8 per cent of seventy-nine patients receiving stilbestrol medication. It has been our impression that these side effects developed earlier in the group of castrated patients. The average dose required for the development of breast changes amounted to 72.7 mg. of stilbestrol in twenty-six patients who were treated with estrogen exclusively and 49.6 mg. in seven patients who were eastrated before or shortly after stilbestrol medication.

Most reports dealing with castration or estrogen medication in the treatment of prostatic cancer have been optimistic so far. The spectacular improvement which has occurred following castration in numerous cases with advanced disease forms a natural inclination to emphasize success and not failures of treatment. In studying



FIG. 1. B, same patient. Biopsy from right breast showing chronic mastitis with proliferation of duct epithelium. No glandular elements are found in section.

given continuously for variable periods, are sufficient to produce symptoms indicating the effectiveness of the drug. In addition to

the effects of treatment we re-examined our patients at intervals of from one to four weeks. The findings on rectal examination

were recorded in diagrammatic drawings every four weeks and compared with previous findings. X-ray pictures of the pelvic girdle or other parts of the skeleton in which development of metastases was suspected for various reasons, were made at intervals of three months. If metastatic bone lesions were known to be present, x-ray plates were taken at shorter intervals. In addition, serum acid and alkaline phosphatase activity was determined on each visit in ambulatory patients and daily in hospitalized patients.

#### CLINICAL RESULTS

In drawing conclusions as to the response to treatment we have endeavored to be conservative in the interpretation of the results obtained. This was done in view of the fact that not sufficient time has elapsed for the determination of final effects of this method of treatment. This attitude finds support by the observation that, as will be discussed later, improvement after treatment, although remarkable in the beginning, was only temporary in several instances.

The clinical results accomplished in our series of eighty-two cases are reported in Table 1. Ten patients (12.2 per cent) died of

TABLE I

	Stil-bestrol	Orchiectomy	Stil-bestrol and Orchiectomy	Total	Per Cent
Died of the disease.....	7	..	3	10	12.2
Died of other causes.....	2	..	2	4	4.9
Alive in improved condition.....	13	3	10	26	31.7
Alive with progressing disease.....	11	..	4	15	18.3
No apparent change.....	27	..	..	27	32.9
	60	3	10	82	100.0

the disease and four (4.9 per cent) died of other causes during the twelve-month period of observation. No apparent changes in the patients' condition was noticed in twenty-seven cases (32.9 per cent) all of whom were subjected to stilbestrol medication exclusively.

Definite evidence of progression of the lesion was observed in fifteen patients (18.3 per cent). This group of fifteen patients was comprised of those in whom repeated rectal examinations revealed further increase in the size of the prostate as well as progressive infiltration into the pelvis. Also included in this group were patients in whom spread of already existent metastases occurred, or patients who developed metastases while they were under treatment. In addition, persistent increase of the serum acid phosphatase activity to levels above normal was considered indication of further progression of the lesion. Although the number of fifteen patients in this group is comparatively small, it is an interesting coincidence that the percentage of failures observed in the patients treated with stilbestrol exclusively was practically identical with the percentage of failures in the patients who were subjected to castration. Eleven cases or 18.3 per cent of the sixty cases who received estrogen alone showed further progression of the lesion as compared to four patients or 18.2 per cent of twenty-two castrated patients.

Favorable response to treatment resulting in clinical improvement of the patients' condition took place in the remaining twenty-six cases (31.7 per cent). Under this heading were placed only patients in whom a sense of well being developed accompanied by gain in appetite and weight. This group of cases was comprised of patients in whom softening, with or without regression in the size of the prostate, occurred following treatment. Also included in this group were patients in whom pain from metastases improved, regardless of whether or not the roentgenological appearance of the metastatic bone lesions revealed tendency to healing. Decrease of the serum acid phosphatase activity took place in all patients of this group if elevation was present before treatment. Omitted from this group were patients who continued to fail although evidence of effectiveness of treatment was apparent from certain findings such as rectal examination, decrease of

pain or obstructive symptoms or decline in serum acid phosphatase activity. Our results indicate that satisfactory response to treatment was obtained more frequently in castrated patients. Thirteen or 51 per cent of twenty-two castrated patients responded favorably to treatment as compared to thirteen or 21.7 per cent of sixty patients receiving stilbestrol medication exclusively.

#### EFFECT OF TREATMENT ON PRIMARY LESION

It must be realized that rectal examination alone is not a satisfactory method for the determination of changes which may develop in the prostate during the course of treatment. However, drawing of diagrams at regular intervals renders rectal examination sufficiently exact to obtain fairly accurate data.

Five (6.1 per cent) of our eighty-two patients died of the disease a short time after the beginning of treatment and we were unable to determine whether changes in the primary lesion had developed up to the time of death. (Table II.)

TABLE II

	Stil-bestrol	Orchidectomy	Stil-bestrol and Orchidectomy	Total	Per Cent
Regression in size...	5	..	2	7	8.5
Softening in consistency ...	6	..	2	8	9.8
Regression in size and softening in consistency.....	19	3	10	32	39.1
Further increase in size and increased induration.....	10	..	2	12	14.6
No apparent change	15	..	3	18	21.9
Period of observation too short ...	5	..	..	5	6.1
	60	3	19	82	100.0

No perceptible changes compared to the original findings on rectal examination were found in eighteen cases (21.9 per cent). Fifteen of these patients were treated with stilbestrol exclusively and three had orchidectomy in addition to estrogen therapy.

Definite increase in the size of the prostate combined with progressive induration and progressive infiltration into the pelvis was observed in twelve patients (14.6 per cent). Ten patients of this group received stilbestrol alone and two were castrated before or shortly after administration of stilbestrol.

Improvement of the rectal findings such as softening or regression in size of the prostate or both was observed in the remaining forty-seven patients (57.3 per cent). Improvement was limited to the prostate gland proper in the majority of the cases. The degree of regression of pelvic infiltration was less impressive as a rule, and in no instance have we been able to observe complete regression of pelvic infiltration once it had developed. It is evident from the figures presented in Table II that castration was the more effective procedure. Evidence of improvement on rectal examination was found in only thirty or 50 per cent of the sixty patients receiving stilbestrol medication exclusively while such improvement took place in seventeen or 77.3 per cent of the group of castrated patients. It also has been our impression that the degree of regression in the size of the prostate was more pronounced in the group of castrated patients. Study of our results revealed that regression as well as softening of the prostate developed in most of the cases four to eight weeks after treatment was started. Changes indicative of favorable response to treatment were noticed one month after treatment in twelve patients and two months after treatment in twenty-three patients. In the remaining twelve patients it took from three to five months until rectal examination revealed improvement. However, such improvement usually did not continue indefinitely. The process of regression came to a standstill six months after beginning of treatment in thirty-five of the forty-seven patients in whom decrease in size and softening of the prostate developed. This end stage was reached after nine months in five cases and evidence pointing to further

regression was found in only two cases after twelve months. The remaining five patients died within the first six months and when last examined tendency to further improvement was apparent.

#### URINARY OBSTRUCTION

No symptoms of urinary obstruction were evident in twenty-four of the eighty-two patients treated. The remaining fifty-eight patients complained of varying degrees of frequency, dysuria and difficulty on urination. Thirty-nine of them had less than 300 cc. residual urine and nineteen had complete or incomplete retention with more than 300 cc. residual urine. In eleven of these nineteen cases suprapubic cystostomy or transurethral resection was carried out before stilbestrol or castration therapy. In the remaining eight patients cystostomy, transurethral resection or temporary drainage by indwelling catheter were employed in addition to orchidectomy and stilbestrol medication.

Study of our results revealed that treatment had no effect on the degree of obstructive symptoms in thirty-four or 58.6 per cent of the fifty-eight patients who complained of such symptoms. Increase in frequency, usually coinciding with increase in the amount of residual urine, developed in nine cases (15.5 per cent). Eight of these patients received stilbestrol exclusively and one patient was castrated in addition to estrogen medication. Improvement of urinary symptoms was obtained in the remaining fifteen patients (25.9 per cent). In six of these fifteen cases (stilbestrol three, orchidectomy + stilbestrol three) treatment resulted in relief from complete urinary retention and in nine patients (stilbestrol six, orchidectomy + Stilbestrol two, orchidectomy one) there was decrease in frequency coinciding with decrease in the amount of residual urine.

However, the interpretation of these results is difficult because, as is well known, improvement of obstructive symptoms may occur without adequate treatment

and such improvement may continue for months or years in some cases of carcinoma of the prostate. Only further observation of these patients will reveal whether improvement of the urinary symptoms was more or less incidental or whether it can be attributed to response to castration and stilbestrol therapy.

#### RESULTS IN METASTATIC CASES

It has been stated before that metastases were found in thirty of the eighty-two patients treated. Twenty-seven patients had metastases to bones and three had metastases to lymph nodes. It is of interest that two of these thirty patients developed bony metastases after they had been under stilbestrol medication for more than six months.

The clinical results accomplished in the group of thirty patients with metastatic lesions were as follows:

Ten patients (bone metastases eight, lymph nodes metastases two) were treated with stilbestrol exclusively. Two of them died of the disease, one patient showed no apparent change, four patients were alive with progressing disease and three patients were clinically improved.

Clinical improvement took place in three patients with metastatic bone lesions who were subjected to orchidectomy alone.

Seventeen patients (bone metastases sixteen, lymph node metastases one) were treated with stilbestrol in addition to castration. Two of them died of the disease and three died of other causes. Clinical improvement of the patients' condition was accomplished in nine cases and evidence of further progression of the lesion was observed in the remaining three cases.

The figures presented indicate that the response to treatment in patients with metastatic lesions was most favorable in the group of castrated patients. Various degrees of clinical improvement were accomplished in twelve or 60 per cent of twenty patients who were subjected to orchidectomy, while a satisfactory response

to stilbestrol medication was obtained only in three or 27.3 per cent of eleven patients receiving estrogen exclusively.

patients who responded favorably to treatment. On the other hand, four to six weeks elapsed in the group of three patients,

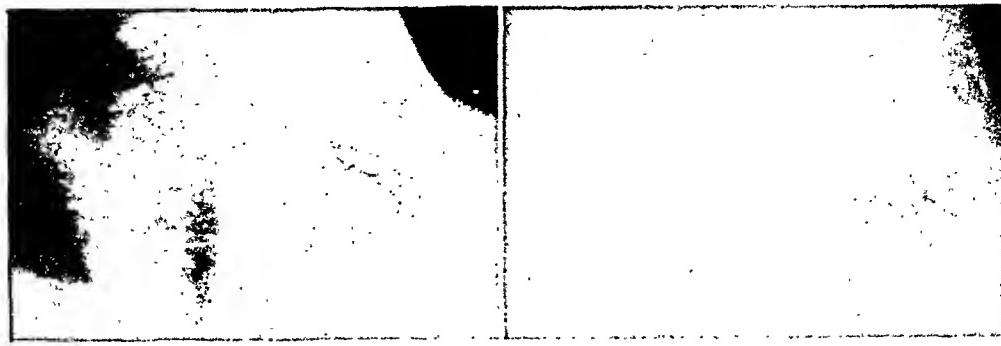


FIG. 2. A, M. K., forty-six, Case No. 43812. Picture taken before orchidectomy showing metastatic lymph node in left supraventricular region. B, same patient. Left supraventricular region six months after orchidectomy. In addition patient received 55 mg. of stilbestrol.

#### PAIN FROM BONE METASTASES

Pain due to skeletal metastases was present in twenty-two of the twenty-seven patients with metastatic bone involvement. Treatment had no influence of the intensity of pain in five cases (castration three, stilbestrol two). In three of these five patients there was even gradual increase of pain during the course of observation (castration two, stilbestrol one). The remaining seventeen patients responded favorably to treatment (castration fourteen, stilbestrol three). This group of seventeen cases includes six patients who had such severe pain before treatment that they were unable to walk without assistance. Complete disappearance of pain was observed in nine patients and eight patients improved to such an extent that they were able to resume light work. However, in four cases of this latter group improvement was temporary only, lasting from three to six months. Attempts to induce renewed relief from pain by increasing the dose of stilbestrol to 3 mg. daily over a period of months did not yield results in these four cases.

Study of our results revealed that remarkable or complete relief from pain occurred within less than one week following orchidectomy in the fourteen castrated

responding to stilbestrol medication, before an analogous degree of improvement was accomplished. Although the number of patients is too small to permit final conclusions, it is our impression that castration is the more effective procedure in obtaining earlier and more spectacular relief from pain.

Analysis of the end results accomplished indicated that lasting effects were obtained only in a limited number of patients. Among twenty-two patients with pain due to skeletal metastases thirteen or 59.1 per cent of the cases showed satisfactory response while the end results were unsatisfactory in five patients, who did not respond to treatment and four patients in whom improvement was temporary only.

#### EFFECT OF TREATMENT ON METASTATIC LESIONS

The effect of treatment on the metastases proper has been very remarkable in the group of patients with lymph node involvement. Complete disappearance of metastatic lymph nodes occurred in each of our three patients with such lesions. Two of these three patients responded to stilbestrol medication exclusively and the third patient was subjected to castration preceding estrogen administration. (Fig. 2A and B.)

The results obtained in the group of twenty-seven patients with metastatic bone lesions were less favorable. Four of these

showed further extension of metastases or development of new lesions in nine patients (stilbestrol two, orchidectomy two, orchi-

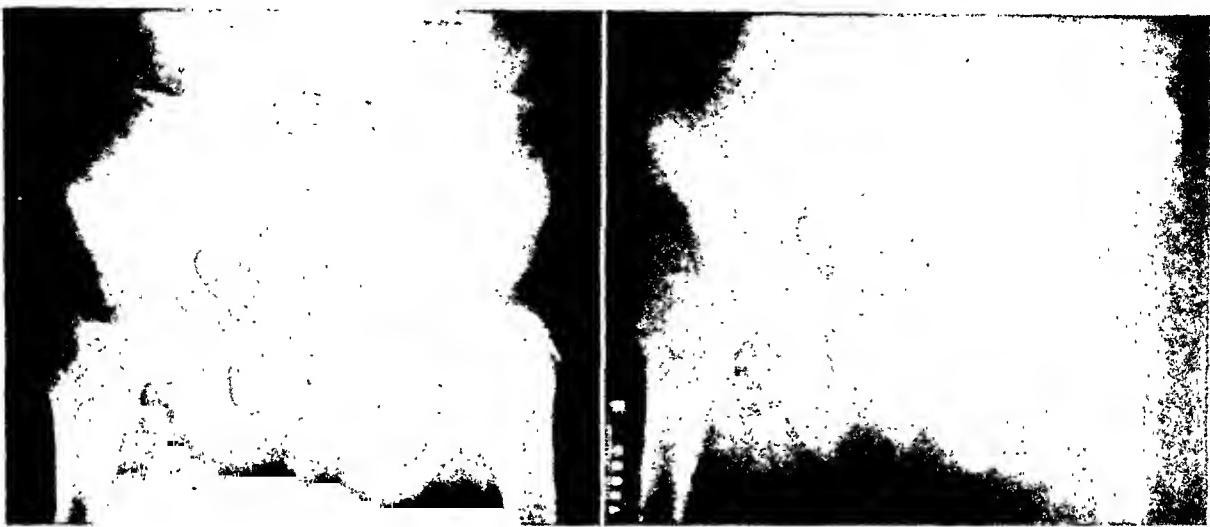


FIG. 3. A, J. B., seventy-four, Case No. 38627. X-ray of pelvic girdle showing patches of increased sclerosis in both iliac bones suggestive of metastatic bone lesions. (Patient was castrated six days later.) B, same patient. Film taken seven months later showing rapid spread of bone metastases. Patient received stilbestrol in addition to castration.



FIG. 4. A, J. Z., seventy, Case No. 42212. X-ray of pelvic girdle showing suspicious area of osteosclerosis in left ischium. B, same patient. Film taken twelve months later revealing metastatic involvement of entire ischium after patient had taken 138 mg. of stilbestrol during twelve months' period.

twenty-seven cases were excluded from this consideration because they died less than three months after the start of treatment. The effects of treatment in the remaining twenty-three patients were as follows: No noticeable change in the appearance of the bone lesions in the x-ray picture was observed in eight cases (stilbestrol three, castration + stilbestrol five). Serial x-ray films

dectiony + stilbestrol five). In three other patients development of bone metastases became apparent after the patients had been under treatment for more than six months (stilbestrol two, orchidectomy + stilbestrol one). Improvement in the roentgenological appearance of metastatic bone lesions was demonstrable in only three patients (stilbestrol one, orchidectomy +

stilbestrol two). Evidence of such improvement was present, in our opinion, if serial x-ray pictures revealed increased sclerosis

fifteen months at the time of writing. (Figs. 3, 4, 5 and 6.)

It is not easy to interpret changes in the



FIG. 5. A, A. S., sixty-five, Case No. 38406. Pelvic girdle film showing metastatic involvement of all bones of the right pelvis. B, same patient. Film taken twelve months after castration showing tendency to return to normal bone structure. Patient received stilbestrol in addition to castration.



FIG. 6. A, B. W., sixty-six, Case No. 43119. Pelvic girdle film showing area of bone rarefaction in left pubis due to metastatic bone involvement from prostatic cancer. B, same patient eight months later showing filling in of the bone lesion in left pubis. Patient received 137 mg. of stilbestrol.

of the lesion as well as tendency to return to normal bone structure. However, it should be stressed that complete or nearly complete regression of the metastatic bone lesion has not occurred as yet in any of these three cases, although two of them have been under treatment for more than

appearance of metastatic bone lesions based on the study of serial x-ray pictures. One must bear in mind that such changes may be artificial due to different exposure, different focus or different technic in developing films. Before arriving at conclusions it is advisable, therefore, to make

sure that none of the factors enumerated interfere with an objective interpretation. This point is of particular importance because spectacular clinical improvement of the patient may influence one's mind as to the interpretation of metastatic bone lesions in the x-ray picture. It has been our experience that such clinical improvement need not coincide with improvement in the roentgenological appearance of bone metastases. This statement is illustrated by the fact that eleven of our patients showed definite evidence of progression of bone lesions although they responded to treatment with decrease of pain, gain in weight and a sense of well being.

#### EFFECT OF TREATMENT ON ACID AND ALKALINE PHOSPHATASE ACTIVITY\*

Consistent elevation of serum acid phosphatase activity above 4.0 King-Armstrong units was found in twenty-seven patients. Twenty-three of these patients had demonstrable bone metastases, one patient had metastatic lymph node involvement and metastatic bone lesions were suspected in the remaining three cases. Elevation of the serum acid phosphatase activity was present prior to castration or stilbestrol treatment in twenty-three of these twenty-seven patients and in four patients (one patient with demonstrable metastases, three patients with suspected bone metastases) increase of the serum acid phosphatase activity developed during the course of treatment.

Normal values for serum acid phosphatase activity were obtained repeatedly in four patients with demonstrable bone metastases, in two patients with suspected bone metastases and in two patients with metastatic lymph node involvement.

Orchidectomy alone (two patients) or in combination with stilbestrol medication (fifteen patients) was carried out in seventeen patients with elevated serum acid

\* We wish to express our thanks to Miss Leona Hudson of our Department of Biochemistry who has carried out all phosphatase determinations. Through her cooperation we have been able to collect valuable data for this paper.

phosphatase activity. The serum acid phosphatase activity in this group of cases varied from 7.5 to 1,350 King-Armstrong units with an average of 150.7 units.

Rapid decrease of serum acid phosphatase activity developed in every instance as early as twenty-four to forty-eight hours after castration. The mean decline in these seventeen patients amounted to 59.6 per cent of the preoperative level on the second postoperative day, to 58.9 per cent on the fourth postoperative day and to 75.4 per cent one week after castration. Thereafter a less precipitous fall continued up to the fourth week after orchidectomy which was followed by a slight transient rise of serum acid phosphatase activity eight weeks after castration. Then a prolonged decline set in until equilibrium was reached two to three months after orchidectomy. (Fig. 7.)

In recording the mean values for serum acid phosphatase activity we have followed the time intervals which were presented by Sullivan Gutman and Gutman in their recent paper dealing with this subject. A comparison of the results obtained is presented in Table III.

TABLE III

Period of Time Elapsed after Castration	Drop of Serum Acid Phosphatase Activity in Per Cent	
	Herger and Sauer	Sullivan and Gutmans
2 days.....	59.6	55
4 days.....	58.9	64
1 week.....	75.4	70
2 weeks.....	80.6	73
3 weeks.....	92.2	66
4 weeks.....	93.3	67
8 weeks.....	89.1	87*
12 weeks.....	94.2	85*
16 weeks.....	94.5	90*
24 weeks.....	95.2	88*

\* Figures estimated from graph presented by Sullivan, Gutman and Gutman as well as A. B. Gutman.

It is evident from this table that our results bear a remarkable resemblance to the figures reported by Sullivan and

Gutmans. It may be coincidence that the decline in serum acid phosphatase activity was more precipitous and more marked in

after four days, 63.8 per cent after one week, 65.4 per cent after two weeks and 90.6 per cent after three weeks. A secondary

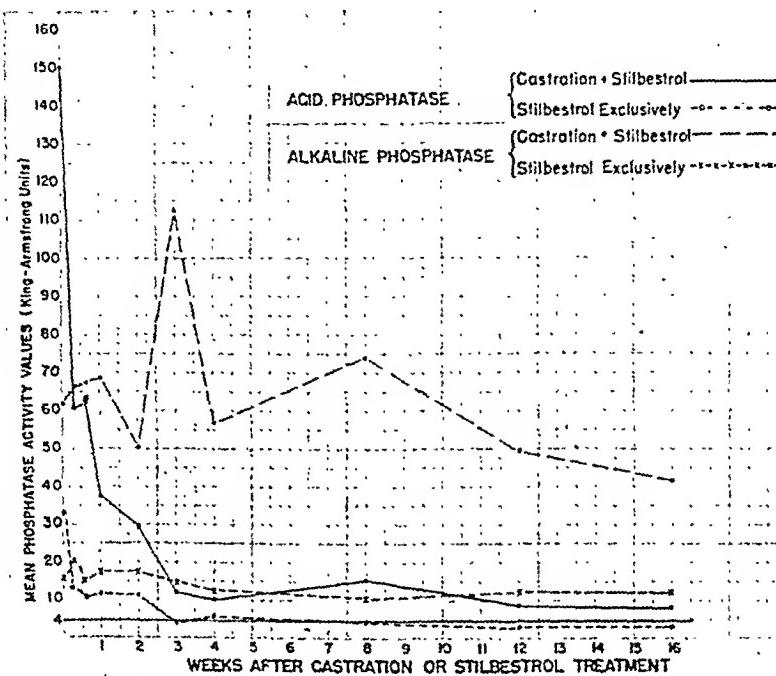


FIG. 7.

our series of cases but we regard it possible that additional stilbestrol medication in fifteen of our seventeen cases may be responsible for this difference. In spite of this difference we consider our results almost analogous to those obtained by Sullivan and Gutmans, since both figures demonstrate a main decline of acid phosphatase during the first week and a secondary transient rise three to eight weeks after orchidectomy.

Stilbestrol medication exclusively was employed in ten patients with elevated values for serum acid phosphatase. In seven of these patients values varying from 5.8 to 90.0 King-Armstrong units were obtained before treatment while elevation of the serum acid phosphatase developed during the course of treatment in three instances.

Decrease of the serum acid phosphatase activity following stilbestrol medication took place in five patients. The mean decline compared to the original values was 56.8 per cent after two days, 68.1 per cent

transient rise to 82.4 and 84.8 per cent developed during the fourth and eighth week of treatment followed by a continuous fall to 90 per cent after twelve weeks of stilbestrol administration. The figures presented indicate that the pattern of decline of serum acid phosphatase activity in these five cases was similar to that in the group of castrated patients. (Fig. 7.)

A moderate increase of serum acid phosphatase activity developed in five patients in spite of stilbestrol medication. The average value in this group of cases increased from 4.4 to 15.9 King-Armstrong units. The highest value determined in one patient amounted to 26.5 King-Armstrong units. In two of the five patients levels above 6.0 King-Armstrong units were obtained before treatment and in three patients elevation developed after stilbestrol had been administered for six, seven and nine months. In two of these latter three cases demonstrable bone metastases developed during the course of treatment

while in the remaining three patients roentgenological evidence of metastatic bone involvement could not be ascertained as yet.\*

It is obvious that the evaluation of results obtained in determining serum acid phosphatase activity must be reconsidered since androgen control has been introduced in the treatment of prostatic cancer. Determination of the acid phosphatase is still a valuable diagnostic aid in the early recognition of bone metastases in patients who were not subjected to castration or estrogen therapy. However, serum acid phosphatase activity determinations have only a limited diagnostic value in patients who were castrated and patients who received or are receiving stilbestrol medication. No elevation or only moderate elevation of the acid phosphatase will be obtained in most of these patients although extensive metastatic bone involvement may be present. This fact should be kept in mind particularly in patients in whom castration or stilbestrol treatment was started at a time when no evidence of bony metastases was present. Development of metastatic bone lesions may occur in these cases while the level of serum acid phosphatase activity remains at a low level. On the other hand, it is obvious that determinations of the serum acid phosphatase activity are of considerable value as an objective indicator of the efficacy of castration or stilbestrol treatment if elevation of the acid phosphatase due to metastatic bone involvement was present before treatment.

It has been pointed out by Huggins and collaborators that numerous patients develop a transient rise in alkaline phosphatase several weeks after castration. This observation has been confirmed by Sullivan and Gutman and our determinations have yielded analogous results. We agree with Sullivan and Gutmans that the effect of castration or stilbestrol treatment on the serum alkaline phosphatase activity is less

consistent than the effect of such treatment on the serum acid phosphatase activity. Our results are practically identical with those of Sullivan and Gutmans: Transient increase in the alkaline phosphatase to about twice the preoperative value developed in thirteen castrated patients during the third week following orchidectomy. (Fig. 7.) No appreciable change of the serum alkaline phosphatase activity was observed in the group of patients who were treated with stilbestrol exclusively.

#### FINDINGS

The results presented indicate that favorable response to castration and stilbestrol administration singly or in combination was obtained in numerous patients with prostatic cancer. However, also little or no improvement was accomplished in an appreciable number of cases.

At the present time it is difficult to predict success or failure of treatment in each individual case before treatment is instituted. Huggins has suggested that correlation of the histology of the tumor with the response to orchidectomy is of prognostic value. He reported that his results were most satisfactory in patients with adenocarcinoma and least satisfactory in patients with undifferentiated prostatic cancer. We have reviewed fifty-four sections of carcinoma of the prostate, which were available for study, but the results of our investigations do not support Huggins's suggestion. In the following we have correlated the histological structure of prostatic cancer in fifty-four patients with the results accomplished:

	Success Per Cent	Failure Per Cent
Differentiated carcinoma . . . . .	31	69
Undifferentiated carcinoma . . . . .	53	47

These figures indicate that no correlation between response to castration and stilbestrol treatment and histology of the

\* In one of these five cases castration was carried out recently resulting in marked decrease of serum acid phosphatase activity within one week after operation.

tumor could be made in our series of cases. On the contrary, we have seen most spectacular improvement in patients with highly malignant small cell carcinomas, while we were disappointed in the results accomplished in some patients with adenocarcinoma of apparently low grade malignancy. Similar views have been expressed by Nesbit and Cummings in a recent publication.

It is obvious that the variability in response to these methods of treatment is explained by the close interrelationship between endocrine functions. Herbst has pointed out that the tendency of the human body to compensate and substitute for the loss of testicular function may be largely responsible for failures. Of particular interest in this connection is one of Herbst's autopsy reports: Enlargement of the adrenals to four and seven times the normal size was found in one patient who had failed to respond to castration. This observation gives support to Huggins's opinion which is that extragonadal stimuli particularly those originating in the adrenal glands may be responsible for failures of castration treatment. It must be kept in mind, however, that in addition to the adrenals the pituitary plays an important rôle in androgen control. Considerable work remains to be done to explain biological changes and compensatory mechanisms which take place in male patients following castration or stilbestrol administration.

In the meantime we must resign to the fact that our experiences rest on empirical grounds. A correct evaluation of these methods of treatment can be made only after data will be collected for more than five years. Besides, it should be distinguished between immediate results accomplished and end results obtained. Nesbit and Cummings have introduced the term "delayed failures" for patients in whom only temporary improvement developed. We consider it significant that we observed four delayed failures in our series of patients who were under treatment for one year and less. Since our figures were com-

piled three months before the writing of this paper we have observed three additional cases of delayed failures and we agree with Nesbit and Cummings that these cases "offer disquieting implications regarding the ultimate outcome in any case." We also believe that the number of delayed failures will increase the longer these patients remain under observation.

However, regardless of the ultimate outcome, castration and stilbestrol treatment singly or in combination is a valuable aid in the treatment of inoperable carcinoma of the prostate. Since other methods of treatment do not yield satisfactory results nothing can be lost and much may be gained although cure should not be expected from orchidectomy or estrogen administration.

#### CONCLUSION

Since 50 per cent of our patients receiving stilbestrol medication exclusively responded with regression or softening of the prostate we are inclined to believe that estrogen administration without castration should have its place in selected cases of prostatic cancer. An indication for such treatment is present in our opinion (1) in patients with operable carcinoma of the prostate who refuse radical operation; (2) in patients with moderately advanced lesions who have little or no symptoms; (3) in patients with comparatively low grade, malignant, well differentiated adenocarcinoma in whom progression of the lesion is slow. This group includes patients who may live for many years without adequate treatment although the diagnosis of cancer has been proved by biopsy (Ferguson); (4) in patients who refuse castration or patients in whom orchidectomy is contraindicated for various reasons.

It is necessary in all these cases to carry out re-examinations at frequent intervals and castration should be carried out as soon as changes occur, which point to progression of the lesions. Such findings are increase in size of the prostate with progressive infiltration into the pelvis, development of obstructive symptoms, increase in

the serum acid phosphatase activity and other signs and symptoms which suggest metastatic spread of the disease.

We believe that castration should be recommended in all patients with prostatic cancer in whom metastases are demonstrable and in patients with a type of lesion which usually has a tendency to rapid progression. In addition, castration should be carried out in patients who do not respond favorably to stilbestrol administration. This procedure has been employed by Herbst, who observed that castration was effective in patients who showed no improvement after treatment with estrogen.

The value of combined stilbestrol medication and orchidectomy is undecided at the present time. In patients who respond favorably to castration additional estrogen administration may accelerate improvement, but our experience has shown that estrogen is ineffective in patients who fail to respond to orchidectomy. This view is supported by Herbst who reported recently, that even increase of the dosage of stilbestrol had no influence on the downhill course of these patients.

Although we have been impressed by the favorable results accomplished in numerous cases, we do not believe that castration or stilbestrol treatment will result in cures. This method of treatment is a valuable adjunct which yields far more favorable results than palliative  $\alpha$ -radiation or interstitial radiation. Neither castration nor stilbestrol treatment can substitute surgical removal of cancer of the prostate in patients in whom the prostate is still encapsulated (Young). Other palliative treatment such as transurethral resection or suprapubic cystostomy will still retain their place in the treatment of carcinoma of the prostate in selected cases.

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IT is of the highest importance that prostatectomy should neither be attempted in the presence of gross infection nor until it has been proved that renal function is adequate. Preliminary ligation and division of the vasa deferentia has banished the troublesome complication of post-operative epididymo-orchitis.

From "A Short Practice of Surgery" by Hamilton Bailey and R. J. McNeill Love (H. K. Lewis & Co. Ltd.).

# SURGICAL PROBLEMS IN THE TROPICS

CAPTAIN LEONARD K. STALKER  
Medical Corps

ARMY OF THE UNITED STATES

**A**SURGEON suddenly removed from private practice to an Army Field Hospital in the tropics is confronted with a great many new and varied problems. Unless he familiarizes himself with the common tropical diseases, he will often be misled. Our Field Hospital is a highly mobile unit equipped to give prolonged definitive surgical and medical care. A large volume and various types of cases have been seen during our several months in the tropics. In the main, surgical procedures are fairly well generalized so only general impressions pertaining to the diagnosis, complications, and treatment of certain problems will be discussed.

## MALARIA AND OTHER TROPICAL FEVERS

All persons who have been in a highly malarious area during the season of incidence are potentially infected with malaria whether they have shown overt symptoms or not. It is well known that chill and over exertion tend to precipitate an attack of malaria in an infected subject. The same effect is produced by wounds, fractures, shock, blood loss, anesthetics, and surgical intervention. It is, therefore, essential to take steps to prevent the development of malaria in such cases. We found that even though all surgical patients received suppressive drug therapy (prophylactic quinine gr. 10 or atabrine gr. 1½) daily that a fever of 101°F. to 104°F. developed in 90 per cent between their seventh and tenth postoperative days. Symptoms or blood findings confirmatory of malaria were present in 70 per cent and in the remaining the diagnosis of dengue was made. For these reasons all surgical patients are now given quinine gr. 10 three times daily or atabrine gr. 1½ four times daily. The incidence of malaria in these

cases is now negligible. Dengue still develops in a certain percentage, but this usually responds to symptomatic treatment and has not been a serious problem.

In many instances our patients have been exposed to the elements for a few days before admission, e.g., aviators who have crashed in the jungle. The surgical problem in these cases has usually been complicated at the onset by malaria. It is not uncommon that the malaria is the more serious of the two. When this occurs, there is usually a slow response to therapy for the malaria as well as for the surgical problem.

This is illustrated by the case of a twenty-four-year old soldier who had extensive second and third degree burns involving more than one-third of his body surface. He had been given first aid treatment elsewhere and evacuated by boat to our hospital. Although he had had no evidence of malaria prior to this, he developed a chill with fever of 104°F. while enroute. He was admitted forty-eight hours after this accident in a critically ill condition. To have treated the burns and its associated physiological problem would not have been difficult, but the combination of the malaria and the burns was nearly fatal.

The patient developed a profound anemia and required multiple transfusions of whole blood. It was not until quinine was given intravenously that improvement took place. Once the fever was controlled by this measure oral therapy was instituted and rapid progress with healing occurred. This experience and others similar have led us to believe that in certain critically ill patients and others in whom the response to oral therapy is slow that quinine administered intravenously is preferred. In cer-

tain cases atabrine administered orally will give the desired results.

*Blood Transfusion.* A number of battle casualty victims will require transfusions of whole blood. In these cases there is considerable risk of transmitting infection from donor to recipient in the process. It is frequently impossible to procure donors who have not been exposed to the risk of malaria infection. Therefore, in selecting the donor the following points should be considered: (1) Donors should be selected from individuals who have not had clinical evidence of malaria. (2) A thick blood smear should show no malaria parasites. (3) The donor aside from being physically fit should not have an enlarged spleen. Even if these considerations are satisfied, it must be assumed that the donors are potentially infected and when feasible 10 gr. of quinine should be taken by the donor six hours before the transfusion. After the patient has received the blood, quinine in treatment dose, as above, is given as soon as the patient's condition permits. Malaria transmitted by transfused blood is unlikely to give rise to fever until at least eight days have elapsed. Any malarial fever developing during the first week is probably due to infection acquired prior to transfusion. In passing one should not overlook the donors, as removal of blood from donors who have latent or suppressive malaria may, after a short interval, precipitate an attack of the disease.

*Diagnostic Problem.* Some of the most difficult decisions we have made have been to decide not to operate on individuals with almost classical pictures of surgical conditions within the abdomen, but who also have malaria. On the other hand surgical complications frequently develop in the course of malaria and one must be careful not to attribute these symptoms to the malaria. Many patients admitted with the diagnosis of acute cholecystitis, appendicitis, perforating peptic ulcer, and intestinal obstruction have been subsequently shown to be suffering from malaria alone.

One patient suspected of having acute cholecystitis had been seized forty-eight hours prior to admission with an upper right-sided abdominal pain, nausea, vomiting and fever of 103° F. There had been no chill and morphine was required for relief of the pain. On examination the abdomen was somewhat distended. The right rectus muscle was spastic with rigidity in its upper half. This area was tender grade 3 on the basis of 4. A suggestive mass was present in this portion of the abdomen, but more careful examination showed this to be the swollen, tender liver edge. A large number of malaria parasites were found on blood smear. The diagnosis of acute malaria with abdominal symptoms was made. Under quinine therapy the fever was subsiding within forty-eight hours and the abdominal symptoms had disappeared.

It is not uncommon for these acute symptoms simulating acute cholecystitis or perforating peptic ulcer to initiate the onset of a severe attack of malaria. They are probably due to the presence of an associated hepatitis. Intestinal obstruction has been suspected in a few who, as early symptoms of their malaria appeared, developed acute diffuse abdominal pain with distention, nausea and vomiting and suggestive obstipation. When appendicitis has been suspected the onset was usually characteristic of that disease, but the fever was disproportionate to the symptoms and their duration. A blood count in some instances showed a leucocytosis and in others, especially if the subsequent diagnosis was dengue, a leukopenia. In the majority a thick blood smear has shown the malaria parasites. On the other hand some of these patients have been diagnosed as having both malaria and a complicating surgical condition, usually appendicitis. When this occurs one can usually distinguish the onset of the two diseases. When the abdominal symptoms are due to malaria, pain develops first and a rapidly rising temperature out of proportion to the abdominal findings subsequently. When a decision cannot be made the patient

should be allowed nothing by mouth and observed for a few hours. A sedative, many times morphine, and a liter of intravenous saline solution are frequently given. In the majority of instances an accurate diagnosis can then be arrived at. In exceptionally rare circumstances a satisfactory decision cannot be made and exploration may be advisable.

#### DEFICIENCY STATES

Prior to coming to the tropics we had been led to believe that deficiency problems would be a frequent complicating factor in the treatment of surgical problems. Actually very few deficiency states with clinical manifestations have been encountered. The response that many of our patients have made to an increased and more varied diet with multiple vitamin supplements has led us to believe that a subclinical deficiency state existed in these individuals. This was particularly noted in individuals after prolonged combat or duty on small sailing ships. We are in agreement that an inadequate supply of vitamins tends to retard wound healing, but in the majority of our surgical problems this has not been manifested.

The healing of wounds, burns, infections, and tropical ulcers was definitely slower in those patients who showed evidence of malnutrition. When anorexia was marked, we found it advantageous to evacuate these patients to a cooler and less monotonous climate. Other than for a change in environment and food the treatment remained the same, but the response was by comparison phenomenal.

The dentist reports that many patients have bleeding spongy gums which have responded to vitamin C and B in combination. Some of the individuals who complained of fatigue, vague aches and pains, anorexia, and nervousness have apparently been benefited by large doses of vitamin B intravenously. Our diet is usually adequate, but is lacking in fresh fruits, vegetables, eggs and milk. We are convinced that it is efficacious to give our personnel and

surgical patients three capsules of multiple vitamins daily.

A case in point was that of a fifty-five-year old civilian member of a small ship crew. For five months his diet had consisted chiefly of tinned rations, namely "bully beef" and hard tack. No fresh vegetables or fruit were eaten. He was admitted to the hospital with dengue and marked anorexia. Ten days following admission what appeared to be a surgical complication developed. A small abrasion at the base of his fifth toe on his right foot was surrounded by inflammation. The entire sole of this foot was darkly discolored and fluctuant, and to the casual observer appeared to be gangrenous. This was secondary to extravasated blood, a large amount of which was evacuated through a small incision. There was no abrasion on the left foot, but a similar extravasation of blood was present. In addition there was hemorrhage into the skin and subcutaneous tissue of the entire body. This was most marked in the anterior and posterior parts of the trunk. Considerable bleeding was present from the gums, mucous membrane of the mouth and posterior pharynx. A number of small dirty appearing necrotic ulcerations were present in these areas. Urinalysis revealed many red blood cells. The diagnosis was scurvy which had been precipitated by the dengue in a previous subclinical deficient individual.

Eight hundred mg. of vitamin C were given intravenously and within six hours the hemorrhage had ceased. Daily therapeutic doses of vitamin C and B, and a diet with fresh fruits and vegetables were given. Within seventy-two hours the patient's appetite returned and he was feeling entirely well. The skin over the hemorrhagic areas exfoliated and in twelve days he was dismissed.

This was an extreme case, but it is highly probable that most soldiers who have spent much time in the tropics are lacking in vitamin C and B. One should, therefore, be on the lookout for evidence of deficiency in their patients and in most cases prophylactic supplemental therapy is advisable.

#### ANESTHESIA

The art of inducing and maintaining general anesthesia in the tropics has

characteristics which are definitely different from those encountered in non-tropical areas. Because of their volatility certain of the general anesthetic agents cannot be administered satisfactorily by the open method. Special accounts may have to be taken of endemic diseases, such as malaria and dysentery. In a highly mobile field hospital simplicity must be the key note of anesthetic technic and equipment, and all equipment for inducing anesthesia must be compact, easily transported, and a supply of new equipment must be continuously available.

In our opinion perhaps the most ideal single anesthetic agent available is the intravenously administered pentothal sodium. Intravenous anesthesia, although not new has been used on a large scale only since the introduction of barbiturates in relatively modern times. This is its first test during a major war. It is especially useful for short surgical procedures: reduction of simple fractures, operations on patients who have been gassed, treatment of burns, quick basal premedication or induction in treating wounds of the thorax and the face and in certain uncontrollable cases of war hysteria. Aside from its use as a sole anesthetic agent, pentothal sodium acts well as a supplement in other types of anesthesia, such as local and spinal anesthesia and in certain instances anesthesia produced by nitrous oxide. Since the barbiturates are such potent respiratory depressants, oxygen should always be available for simultaneous administration. This can easily be procured from local air corps units and administered through the Boothby, Lovelace, Bulbulion oxygen mask. The transportability of this equipment has made it possible to give oxygen therapy to some of our seriously ill surgical patients. Intravenous anesthesia is particularly adapted to war surgery because of the rapidity of the induction and the emergence from the anesthesia, simple equipment for use, ease of administration and their non-explosive qualities. In addition to this repeated administration does

not produce any ill effects; there are no postanesthetic complications; it produces little lowering of blood pressure, and has a favorable psychic effect on over-anxious patients.

Spinal anesthesia has been used second in frequency by us. We believe that some form of preoperative medication is advisable, but many patients will have to be operated on without the advantage of this medication. We have overcome this in some cases by the intravenous administration of morphine sulfate or pentothal sodium. Spinal anesthesia is ideal for reduction of fractures, for amputations or treatment of wounds of the lower extremities and for operations on the lower part of the abdomen and rectum. As a matter of fact, due to the climatic difficulty involved in producing satisfactory abdominal relaxation with volatile anesthetics, we have come to depend almost entirely on spinal anesthesia, either alone or in combination with intravenous pentothal sodium, in operations for abdominal conditions. Now that continuous spinal anesthesia has been proved so satisfactory, there is probably little reason why it will not soon be used by the trained anesthetists in the field.

Until such a time, however, ether anesthesia will continue to be especially indicated in cases of intra-abdominal injuries which may involve prolonged anesthesia. Its main disadvantages in the field are long induction, slow recovery, volatility and inflammability of the agent, frequent pulmonary complications and the need for increased nursing care. If ether is to be used the intratracheal method of administration is preferred. This cannot be carried out satisfactorily unless a closed system of administering ether vapor such as can be obtained with the ordinary gas machine is available. If such is available, it opens up the possibility of using a mixture of nitrous oxide and oxygen either alone or in combination with ether.

The greatest disadvantage of these methods is the bulk and complexity of apparatus necessary for its administration. This also necessitates a constant source of supply of heavy cylinders, which may be delayed by the uncertainty of transportation during combat. However, the rapid improvements made in portable gas machines and small vaporizing units may soon make this type of anesthesia practical in the field.

Due to its volatility ethyl chloride cannot be used locally, but in many instances it has been useful for quick inductions in operations or dressings of short duration.

Local anesthesia either alone or supplemented should be used whenever possible. Its merits and disadvantages are obvious and will not be discussed. Obviously there is no single ideal anesthetic for use in the tropics, but by selecting the anesthetic for the individual case satisfactory results can be obtained.

#### MISCELLANEOUS

The problems related to malaria, deficiency states, and anesthesia have been the most common and for this reason have been discussed at some length. The association of the troops with natives makes them more susceptible to such diseases as yaws, leprosy, hookworm, tropical ulcer and fungus infections. All manner of skin complaints occur in the tropical areas and due to the frequent association of an abscess, cellulitis, lymphangitis, and lymphadenitis the surgeon may be concerned. Any small scratch or insect bite tends to suppurate if the general resistance is weakened by malaria or other debilitating diseases. Carbuncles and furuncles are commonly seen in these cases.

Likewise any slight wound, abrasion, or insect bite may serve as the starting point for one of the dreaded tropical ulcers. This is a putrid sloughing phagedaena commonest on the lower limbs in hot moist climates. The upper extremities and other

exposed parts of the body may be attacked. Once the ulcer develops it extends in all directions excavating as it goes, leaving a stinking central pit in which the tissue structures and even the periosteum of bones may be involved in a common gangrene. These usually run a chronic course and if untreated require some months for healing with scarring and even contractures. No completely satisfactory treatment has as yet been designed. In our cases an endeavor has been made to clean up all dietary deficiency and any debilitating disease such as malaria. The local treatment has been to treat the cellulitis by rest, heat, and elevation and to keep the ulcerated area clean and covered with sulfanilamide powder. Some remarkable results have been obtained, but in some cases the ulcer will progress in spite of therapy. These cases are best evacuated to a non-tropical area where healing by the same measures is usually rather prompt.

#### SUMMARY

A discussion has been presented of some of the problems which have confronted us in our surgical work in the tropics. The majority of these problems have been in relationship to malaria, some deficiency state, or the administration of a satisfactory anesthetic. Malaria has been a complicating factor in 70 per cent following surgical intervention. Since surgical patients have been given therapeutic doses of quinine or atabrine throughout the period of hospitalization the incidence of malaria has been negligible. Very few deficiency states have been encountered, but in most cases prophylactic supplemental therapy has seemed advisable. Because of their volatility certain of the general anesthetics are difficult to administer. There is no single ideal anesthetic for use in the tropics, but intravenously administered pentothal sodium has proved most useful.

# METAL SHELF FOR HIP DISLOCATION\*

ROSS SUTHERLAND, M.D.

AND

M. JOHN ROWE, JR., M.D.

Medical Director,  
Tichenor Orthopedic Clinic for Children

LOS ANGELES, CALIFORNIA

Assistant Orthopedist,

Tichenor Orthopedic Clinic for Children

LONG BEACH, CALIFORNIA

THE treatment of subluxation of hip in children often requires the construction of a so-called "shelf" to

was considered because this particular alloy has great strength, is malleable and increases in strength with molding, and



FIG. 1. Inconel metal hip shelves; deep, coarse-threaded screws.

replace the deficient superior margin of the acetabulum. The usual bone shelf operation, regardless of the particular technic used, often necessitates arthrotomy of the joint, wide separation of muscle planes and origins or insertions, and extensive vessel ligation to allow adequate exposure of the operative area and the bone donor site. Such procedure is usually shocking because of three main causes: loss of blood, direct bone trauma from osteotomes, and long operation and anesthetic time. The possibility of ankylosis is always present and a late complication often seen is marked abductor muscle weakness caused by stripping of the gluteus medius and minimus origins from the ilium.

Because of the morbidity from the standard operation, the prolonged cast immobilization necessary and the recent extended use of inert metal as internal fixatives in bone surgery, interest was aroused in the possibility of facilitating the technic of surgical retention of the dislocated hip.

The first problem encountered was that of the choice of a suitable metal. Inconel

has great resistance to usual causes of deterioration. However, it has been found to be somewhat irritating to soft tissue and has been discarded in favor of "18 and 8" stainless steel. Vitallium seemed brittle for the type of strength required and has not been used.

Striving for simplicity and paucity of foreign material, a simple buttress type of shelf was constructed which could be fastened to the ilium to replace the lacking acetabular rim. Previous use had shown the superiority of deep coarse thread screws for plate fixation as opposed to the efficiency of nails for muscle insertion replacement.

The desirable method would use a minimal size muscle splitting incision away from major vessels, would not require disruption of muscle attachments, and would allow extracapsular fixation. Such requirements were met in the short lateral longitudinal incision splitting the gluteal muscles above the trochanter in the line of their fibers to allow exposure of only a small area of the wall of the ilium above the acetabulum. A very small metal shelf can

\* From the Tichenor Orthopedic Clinic, Long Beach, California.

then be applied rapidly and held in place with screws in the fairly thick bone of this region. Closure is simple and with adequate

with inconel nails. Roentgenograms several days later showed loosening of nails and partial subluxation which could not be corrected by

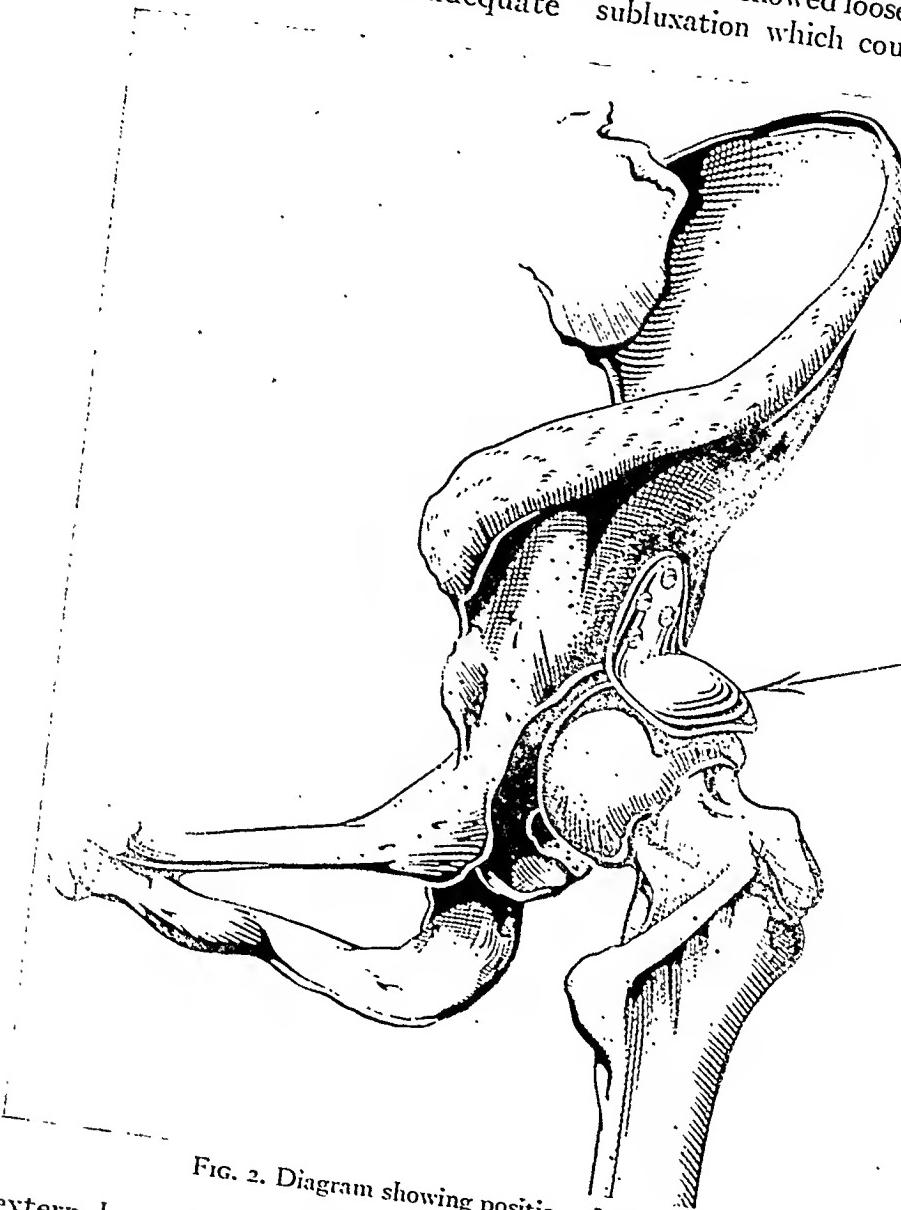


FIG. 2. Diagram showing position of shelf.

fixation no external cast is required. Motion of the hip may be instituted very early with early guarded weight bearing.

Three operations have been performed so that a preliminary evaluation of the procedure may be made.

CASE I. S. W., a female, age four and one half years, had an untreated congenital dislocation of the left hip. Symptoms were severe limp and shortening. The dislocation could be reduced at open operation but could be maintained only by direct pressure on the femoral head. On October 22, 1941, an inconel shelf was inserted and fastened to the ilium

traction. On November 12, 1941, reoperation was performed and the nails were replaced by deep, coarse-thread inconel screws. A single centrally placed arthrodesing nail was inserted in an attempt to guarantee fixation without cast. Sulfanilamide powder was inserted to insure against infection. The child suffered a fall at home which was apparently not important at that time. The nail was removed and a cast applied on December 17, 1941, as a precaution against re-displacement. Walking in the single spica was encouraged and the cast was removed on January 22, 1942.

At this time a small sinus in the incision was found draining a clear yellow fluid, apparently

synovial in origin. There was also an increased valgus at the knee which x-rays showed caused by a healed greenstick supracondylar femur

Return of function and mobility was rapid. Roentgenograms showed a normally located hip with very little epiphyseal irregularity and

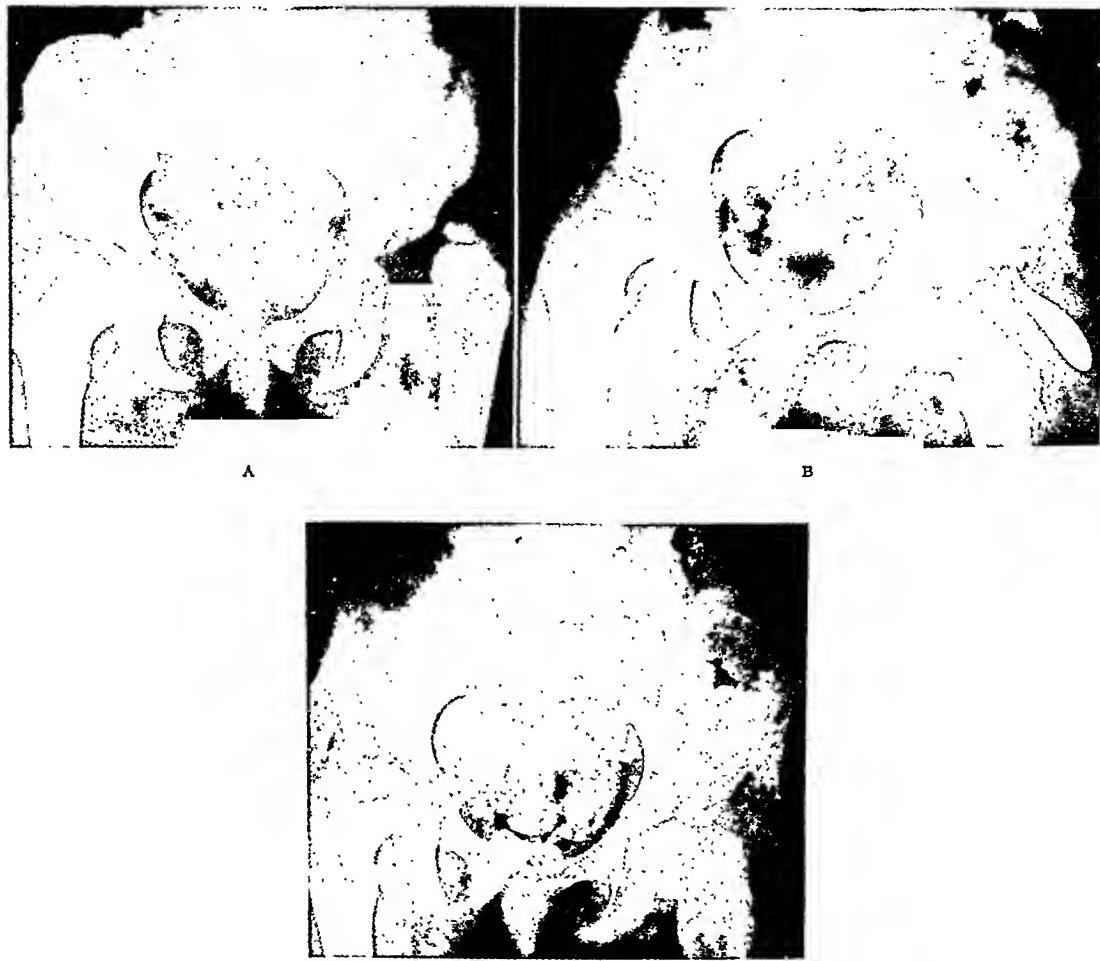


FIG. 3. Case 1. A, original x-ray; congenital dislocation left hip. B, postoperative x-ray; metal shelf in place. C, x-ray six months after operation; metal shelf removed.

fracture. Evidently the fall had been severe enough to cause a fracture without being able to distort the hip or shelf. Films of the hip showed numerous opacities in the soft tissues which were thought to be agglomerations of sulfanilamide crystals. There was also proliferation of bone at the base of the metal shelf in the region of the superior acetabular margin. Hip motion returned rapidly.

On April 1, 1942, the shelf was removed, it was firmly fixed and the screws had to be released and completely unscrewed. A small medial supracondylar osteotomy to correct the valgus was performed and a walking spica cast applied which was removed on May 12th.

a well proportioned acetabulum. Despite the multiplicity of procedures and the difficulties encountered in this, the initial case, at no time was any evidence of shock noted and recovery from each anesthetic was similar to that following a minor procedure.

CASE II. A. McC., a female, age five and one-half years suffered with paralytic subluxation left hip. She had poliomyelitis in infancy with sequelae of paralysis of the shoulder and hip. There was good leg and arm musculature. Because of weak abductors the hip showed instability, a shallow acetabulum, and clinical "telescoping." On March 18, 1942, surgery was performed through a lateral longitudinal

muscle-splitting incision. Only a small area of ilium was exposed and a small metal shelf was inserted and fastened with screws. The entire

CASE III. J. S., a female, age fifteen years, had paralytic subluxation of the left hip, right paralytic genu recurvatum, and scoliosis for



A



B

FIG. 4. Case II. A, original x-ray; paralytic subluxating left hip. B, x-ray three months after operation; metal shelf in place.



A



B

FIG. 5. Case III. A, original x-ray; paralytic subluxating left hip. B, x-ray three months after operation; small steel shelf in place; note calcification about shelf.

operation took less than twenty minutes, there was no shock, no external fixation was used, and the child was moving about in bed the following day with almost no discomfort. She was allowed to walk with crutches in one week and bear weight at four weeks. Two months after operation the patient was walking well without her previous leg brace or crutches, there was no telescoping, mobility was excellent, and stability was increased. It is planned to leave the shelf in place for observation with removal if clinical signs so indicate.

which extensive spinal fusion had been done elsewhere as well as bilateral foot stabilizations. The patient walked in bilateral long double upright braces with a severe "lurching gait" on the left which threatened her lumbosacral stability and caused numerous falls. On June 24, 1942, a small steel shelf was inserted with two screws. No cast was applied, the operating time was less than thirty minutes, and there was no shock. Ambulation was allowed at four weeks. There was perfect healing. Two months postoperatively definite improvement in gait

was noted and the patient was subjectively happier because of increased assurance and less tendency to fall.

It has seemed advisable to present this work at such an early period because of the definite advantages obtained. The procedure is simplified and facilitated by the application of previously used materials and technics to a particular problem. Operative shock is lessened, morbidity, hospitalization time, and cast immobilization period are lessened, and the economic problem to the individual is decreased. The opportunities for severe epiphysitis, joint malformation, and ankylosis seem definitely minimized by less trauma and early function. Further work is in prog-

ress to obtain further simplification and efficiency.

#### SUMMARY\*

Insertion of an internal metal prosthesis to replace a deficient superior acetabular margin in subluxating hips is a feasible and practical procedure. Such an operation can be more simple, more efficient, and less shocking than the conventional procedure.

\* Four additional operations have been performed since submission of this report. Three were adults with long standing hip dislocations and one was a child with tendency to subluxation following arthroplasty for ankylosis of the hip. The results have been good with steel shelves which were well tolerated and increased stability of the hips.



PATIENTS with fractures of the lower limb never should be transported until after splinting has been applied. Hospitalization is necessary for the modern treatment of fractures of the leg. Order x-ray examination before deciding upon the method of further treatment.

From "Fractures and Dislocations for Practitioners" by Edwin O. Geekeler (Williams & Wilkins Company).

# OMENTAL RESPONSE\*

## OBSERVATIONS ON 160 CONSECUTIVE AUTOPSIED CASES

ROBERT E. ROTHENBERG, M.D.

Adjunct in Surgery, Jewish Hospital

BROOKLYN, NEW YORK

AND

PHILIP ROSENBLATT, M.D.

Moritz Rosenthal Fellow, Mount Sinai Hospital;  
Assistant Pathologist, Jewish Hospital

NEW YORK, NEW YORK

THE great omentum is usually referred to as the active protector of the peritoneal cavity and it is claimed that it travels about from place to place in order to combat infection. Many authors speak of it as the policeman of the abdomen and others compare its activities to those of a fireman who rushes to the scene of trouble to extinguish the blaze. However, during the performance of abdominal operations, it has been observed on innumerable occasions that the omentum was far distant from the site of infection. At the autopsy table, too, the omentum is frequently found to be remiss in its alleged duty of walling off infection and fails to fulfill its supposed function as protector of the abdominal cavity.

Because of this apparent discrepancy between the accepted theories and our own observations, we have undertaken to investigate the functions of the great omentum more thoroughly. In a previous communication,<sup>1</sup> the omental motility and response in dogs was reported and the conclusion was reached that the omentum played a relatively minor rôle in actively walling off most intraperitoneal infections. The experiments tended to show that the omentum is effective in limiting the spread of infection only when it happens to be in the vicinity of the inflammation. It was concluded that the omentum did not patrol the abdominal cavity with active vigilance nor did it seek out areas of trouble.

To gain further knowledge of omental activity and to discover more about its rôle in mechanically walling off an area of inflammation, the omenta in 160 unselected autopsies were closely studied. It was be-

lieved that further light might be shed on the cause for the non-appearance of the omentum in those cases in which one would expect it to act as a protective force. In cases exhibiting evidence of previous intra-abdominal infection, we hoped to discern the part which the omentum had played in the recovery from the lesion. If, as it has been taught, the omentum walls off and localizes areas of infection, one would expect to find adhesions in the involved region. By the same token, the failure of the omentum to form adhesions would indicate that it had not responded as a mechanical protective agent. No attempt has been made in this study to evaluate the phagocytic or immunologic functions of the great omentum. This phase of omental physiology will be reported in a later communication.

Of the 160 autopsied cases, seventeen were found to have active intraperitoneal infection at the time of death. In only seven of these seventeen cases, or 41 per cent, were there omental adhesions in the area of infection. The other ten cases showed no omental response in the form of adhesions to the involved area. Table I gives the diagnoses in those cases with active intraperitoneal infection at the time of death, the presence or absence of omental adhesions, and the duration of the intra-abdominal disease process prior to death.

The following autopsy briefs indicate more precisely the pathological conditions encountered and the position of the great omentum in relation to the site of infection.

CASE I. No. 41-21. C. R., a forty-six year old man, died of intestinal hemorrhage com-

\* From the Department of Surgery and Laboratories, Jewish Hospital of Brooklyn.

plicating a virulent influenzal pneumonia. At autopsy he also had a perforation of the ileum and there was 300 cc. of sanguineous fluid in the peritoneal cavity. A rather fatty omentum was found folded on itself in the midline, not adherent to the ileal perforation. On physical manipulation of the omentum at autopsy, it was easily drawn down over the site of perforation.

TABLE I

Necropsy No.	Intra-abdominal Finding	Presence or Absence of Omental Adhesions	Duration of Disease Prior to Death
41-21	Perforated ileum; peritonitis	No	2 days
41-36	Perforated cecum; peritonitis	No	2 days
41-46	Postoperative peritonitis	Yes	3 days
41-53	Miliary tuberculosis of peritoneum	No	28 days
41-79	Gangrene of small intestine	No	3 days
41-113	Perforated duodenal ulcer	No	4 days
41-138	Acute cholecystitis; cholangitis	No	4 days
41-139	Postoperative peritonitis	Yes	24 days
41-163	Acute cholecystitis; liver abscesses	Yes	14 days
41-175	Perforated colon; peritonitis	No	5 days
41-187	Strangulated hernia; peritonitis	No	5 days
41-203	Ruptured appendix; peritonitis	Yes	9 days
41-206	Perforated ileum; peritonitis	No	3 days
41-208	Ruptured appendix; peritonitis	No	8 days
41-214	Liver abscess; chronic cholecystitis	Yes	21 days
41-216	Postoperative peritonitis	Yes	7 days
42-33	Acute cholecystitis; peritonitis	Yes	28 days

CASE II. No. 41-36. M. T., a seventy-six year old man with carcinoma of the cecum developed an intussusception which perforated. At autopsy there was free gas within the peritoneal cavity as well as about 100 cc. of fecal fluid. The omentum was found in the left lower abdominal quadrant far distant from the

site of perforation. Manipulation easily brought the omentum within reach of the lesion.

CASE III. No. 41-46. W. C., a four and one-half year old male child, died of a purulent peritonitis secondary to operative intervention for intussusception. *Bacillus coli* and non-hemolytic streptococci were cultured from the peritoneal cavity. The omentum was found adherent to the anterior abdominal wall as well as to the site of the infection in the right lower abdominal quadrant. There were also adhesions between the omentum and loops of small intestine.

CASE IV. No. 41-53. H. R., a seventy eight year old man, was found on autopsy to have a miliary tuberculosis of the peritoneal cavity. There were 3,500 cc. of yellow fluid in the peritoneal cavity but no omental adhesions. The omentum was found to be lying high up in the epigastrium. There were innumerable miliary tubercles in the omentum.

CASE V. No. 41-79. I. H., a seventy two year old man, died of acute coronary occlusion. He also had gangrene of the small intestine secondary to a strangulated intra-abdominal hernia. The great omentum, at necropsy, was found lying free in the midline. It was neither contained within the hernial sac nor was it near the gangrenous bowel.

CASE VI. No. 41-113. M. G., a sixty-nine year old man, died following operation for a perforated duodenal ulcer. At operation, the great omentum had been tacked with sutures to the site of perforation. Nevertheless, on cutting these tacking sutures at autopsy, the omentum slipped easily away from its moorings. There were no omental adhesions despite the fact that four days had elapsed between the date of operation and death. The operative chart stated that at laparotomy the omentum had been found in the right lumbar gutter nowhere near the ruptured ulcer.

CASE VII. No. 41-138. W. S., a fifty-seven year old man, died of *Bacillus coli* bacteremia and cholangitis which complicated an attack of acute cholecystitis. The great omentum, although of adequate length, was found lying free within the peritoneal cavity and was not adherent to any structures. This patient gave a five-year history of gallbladder disease and the terminal acute phase was of four days' duration.

CASE VIII. No. 41-139, M. S., a fifty-five year old woman, was operated upon for

papillary cystadenocarcinoma of the ovaries. She developed peritonitis and *Salmonella typhi murium* was isolated from the abdominal cavity. At autopsy, the omentum was adherent to the stomach and to the suture line in the anterior abdominal wall. However, it did not appear to have walled off the peritonitis or to have attempted localization of the infection.

CASE IX. No. 41-163. M. K., a sixty-six year old man, died following an attack of acute suppurative cholecystitis with multiple liver abscesses. Cholecystotomy had been performed one and one-half years prior to death. At autopsy the omentum was adherent to the under portion of the operative scar and to the gallbladder area. The adhesions, however, did not limit the spread of infection for there was a generalized peritonitis as well. *Clostridium welchii* was cultured from the peritoneal fluid. The organisms were thought to have originated in the infected bile.

CASE X. No. 41-175. Y. B., a sixty-three year old woman, died as a result of perforation of a carcinoma of the rectosigmoid colon. There was a generalized fecal peritonitis. The omentum was far from the site of perforation and there were no adhesions. Manual manipulation at necropsy easily brought the omentum over the site of perforation.

CASE XI. No. 41-187. B. G., a fifty-seven year old woman, died as a result of a purulent peritonitis secondary to operation for strangulated femoral hernia. The omentum lay free within the peritoneal cavity and did not approach the femoral ring, although its length, 28 cm., was far greater than average. Non-hemolytic streptococci were isolated from the peritoneal pus.

CASE XII. No. 41-203. I. L., a two and one-half year old female child, died of peritonitis following appendectomy for a ruptured appendix. The omentum was involved in some adhesions in the region of the appendix. The omentum appeared to be passively rather than actively involved in the adhesive process. *Bacillus coli* and non-hemolytic streptococci were cultured from the peritoneal pus.

CASE XIII. No. 41-206. J. B., a fifty-six year old woman, died of peritonitis following operation for gangrene of the ileum due to strangulation by a peritoneal band. The omentum was curled up in the upper part of the abdomen far distant from the ileum. Non-

hemolytic streptococci were cultured from the peritoneal pus.

CASE XIV. No. 41-208. F. N., a forty-year old woman, died as a result of a perforated appendix with secondary generalized peritonitis. The peritonitis existed for at least four days prior to death. At autopsy, however, the omentum was found rolled up toward the stomach, none of it extending down to the region of suppuration. No omental adhesions were present. *Bacillus coli* was cultured from the peritoneal exudate.

CASE XV. No. 41-214. M. F., a sixty-one year old woman, died of liver abscesses complicating chronic gallbladder disease. At necropsy the omentum was adherent to the anterior abdominal wall in the right upper abdominal quadrant and also to the falciform ligament. There was also a spontaneous cholecystoduodenal fistula.

CASE XVI. No. 41-216. A. F., a thirty-nine year old man, died of bilateral suppurative nephritis complicating adenocarcinoma of the urinary bladder. At necropsy, a peritoneal abscess was found from which *Bacillus lactis aerogenes* was cultured. The omentum was adherent to the pelvic structures and bowel but did not participate in the localization of the abscess which was entirely surrounded by loops of intestine.

CASE XVII. No. 42-33. T. H., a forty-one year old woman, died of acute hemorrhagic pancreatitis. On surgical intervention, widespread fat necrosis was noted but there were no omental adhesions. The patient died several days postoperatively and adhesions between the great omentum and the undersurface of the abdominal incision were uncovered. There were no adhesions, however, in the region of the pancreatic necrosis. There was also 200 cc. of purulent material within the peritoneal cavity from which *Bacillus coli* and *Staphylococcus aureus* were isolated.

Among the 160 cases studied, there were an additional twenty-nine patients who had a definite history and presented anatomic evidence of previous intraperitoneal infection. In only eleven of these twenty-nine patients were there omental adhesions at the site of the previous inflammation. Thus, permanent omental adhesion occurred in but 38 per cent of those patients.

who had recovered from a past abdominal infection. Table II shows the lesions which had been present in this group and the incidence of resultant adhesions.

TABLE II

Diagnosis	No. of Cases	Omental Adhesions
Cholecystitis.....	14	4
Appendicitis.....	9	5
Diverticulitis.....	1	1
Salpingitis.....	4	1
Ulcerative colitis.....	1	0
Total.....	29	11 (38%)

From Tables I and II it is seen that forty-six of the 160 cases at one time or another presented an intraperitoneal infection. Omental response in the nature of adhesion formation occurred in eighteen of the forty-six cases, or in 39.1 per cent. This appeared to be a rather poor response if the great omentum were actually the efficient active protective force which we have been taught it is. It was, therefore, believed that a close analysis of the cases should be undertaken to determine why the omentum had failed to respond by adhering to the site of inflammation. If good reasons could be brought to light which would explain the non-appearance of the omentum in the majority of cases (60.9 per cent), one might still believe it to be a potent localizing agent in peritoneal infection. However, if the great omentum was found to be free to adhere to the inflamed area but did not do so, one would conclude that its duties did not involve the active walling off of infected regions.

In considering causes for omental failure, one must first ascertain whether sufficient time had elapsed for the omentum to reach the site of infection. Theoretically, one might postulate that the infection was so severe and overwhelming that the patient succumbed before the omentum could function as a localizing agent. However, it is observed (Table I) that in the ten cases

in which no adhesions were formed the infection had been present for an average of 6.4 days before death occurred. Certainly this should have been ample time for the omentum to respond actively to the peritoneal insult. All surgeons have encountered patients who have had symptoms for only a few hours, yet on abdominal exploration the omentum has been found intimately adherent to the inflamed viscus.

It is not possible that the omentum failed to travel to the involved region because the infection was not severe enough to elicit a response. In almost all of the reported seventeen cases in Table I, frank pus was found within the peritoneal cavity and the process was sufficiently virulent either to cause the patient's death or contribute toward it.

It might be argued that the omentum was unable to get to the involved area because of previous adhesions elsewhere in the peritoneal cavity. However, no such old omental adhesions were found in any of the cases reported here. It could be said, therefore, that the omentum was completely unhampered in its response.

Another question which must be considered is whether the great omentum was large enough to reach the affected area. As far as its length is concerned, in the 160 cases, the omentum averaged 15.6 cm. in the midline as measured from the transverse colon to its free edge. In the seventeen cases with active intraperitoneal infection at the time of death, the average omental length was essentially the same, namely, 15.8 cm. It must be concluded, therefore, that the omentum was of adequate length to reach the site of inflammation had it been inclined to make the attempt. Furthermore, in each instance, it was observed at necropsy that the omentum could readily be moved by hand to the area of infection.

#### CONCLUSIONS

The omentum was studied in 160 unselected cases, of which forty-six at one

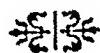
time or another showed evidence of intraperitoneal infection. Omental response in the form of adhesions occurred in eighteen of these cases, or 39.1 per cent. This appeared to be a poor response if the great omentum were actually the active protective force it is supposed to be. An analysis of the lack of omental response showed that it could not be explained on the basis of insufficient time, insufficient severity of the infection, previous adhesions limiting the mobility of the omentum, or because the omentum was anatomically unable to reach the affected area due to inadequate length.

These findings lend credence to our previous impression that the great omentum does not respond to intraperitoneal insult by actively moving to the site and forming adhesions in the involved area. We are not prepared to state that the omentum plays no part in intraperitoneal infection for numerous studies have shown that it

does throw out an exudate and that it often does become involved in delimiting adhesive processes. However, in those instances in which adhesions were formed, as in 39.1 per cent of our cases, the adhesions appeared to be the result of the organization of such an exudate upon the surface of the omentum. It is our opinion that adhesions are formed only when the omentum happens to be at or near the site of infection, and that the omentum takes part in the local inflammatory process in a passive manner. If the omentum plays a more active and vigorous rôle, we are at a loss to explain its failure to form adhesions or appear at the site of infection in the majority of the cases reported here.

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# RHINOPLASTY AND ITS RELATION TO RHINOLOGY\*

GEORGE D. WOLF, M.D.  
NEW YORK, NEW YORK

PLASTIC surgery of the nose, it may be said, has gone through at least three phases during our own era. At first, rhinoplasty was looked upon as a sort of illegitimate child and left in the hands of charlatans and beauty specialists. Then came the plastic surgeons who have done splendid work in this field and to whom important contributions must be credited. Rhinologists are finally realizing that rhinoplasty is a definite branch of their specialty; that not only is the external nose important for its cosmetic effects, but that it plays a vital part in the functions of respiration. We are beginning to realize that in many cases deformities of the external nose may disrupt the respiratory air currents, interfere with breathing, predispose to colds and sinusitis, be responsible for chronic headaches, and make the patient a chronic nose sufferer. That these patients cannot be helped by nasal septum surgery or turbinectomy has been demonstrated over and over again. On the other hand, proper correction of the nasal deformity frequently yields most gratifying results. Now that we have come to realize more and more that external nasal deformity is closely interlaced with nasal function and pathology, it is reasonable to conclude that just as the rhinologist must familiarize himself with rhinoplastic technic, so must the rhinoplastic surgeon be thoroughly trained in rhinology.

Undoubtedly, great progress has already been made in this direction. Scientific papers are beginning to appear by reputable rhinologists, in which the functional aspects of rhinoplasty are emphasized. Competent nasal surgery, suitably selected for each individual case, demands absolute familiarity with the physiology and the

anatomy of the nose as an organ of respiration and olfaction. Little by little, as the physiology of the nose is better understood, our surgical methods will be more rational.

## FUNCTIONS OF THE EXTERNAL NOSE

As a result of a great deal of experimental and clinical researches, the part the external nose plays in the physiology of respiration and olfaction has been considerably elucidated. We now know definitely that it is the purpose of the external nose to guide and direct the inspired air, so that it can most effectively serve these combined nasal functions. It is a fact that the inspiratory air current does not take a straight course through the nasal passage but that it describes a gently directed upward curve from the anterior to the posterior nares. Paulsen, in 1882, experimenting on human cadavers, showed that the main current of inspired air was lifted to above the inferior turbinate passing over the region of the middle turbinate and then descending to the choanae. Francke, in 1893, working with prepared models, confirmed the above findings but in addition demonstrated that the current, in its passing through the fossa, always formed, at certain points, definite whorls or eddies. The object, apparently, is to conduct the main current at a slowed rate over the respiratory region and at the same time enable portions of it, by slow drift and by eddies, to come effectively in contact with the olfactory areas.

Goodale, in 1896, and Lack, in 1906, practically confirmed these findings. They proved by their experiments that a stream of inspired air does not pursue a straight course from the nostril to the choana, but

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passes in a wide curve which begins at the nostril, extends through the olfactory fissure, and ends in the upper part of the choana. The current of air does not touch the inferior turbinate except for small eddies which curl, (1) against the face of the sphenoid, (2) over the inferior turbinates, and (3) into the sphenoid sinus.

The experiments of Proetz shed further light on the nature of this air current. Proetz demonstrated that the direction of the air current is determined by two factors: the first is the shape and position of the nostril, and the second, the angle at which the inspired air impinges against the slope of the bridge of the nose. He also showed that amputation of the middle turbinate does not materially affect either the inspiratory or the expiratory currents. When, however, obstacles are introduced either on the septal or lateral walls, pronounced changes are observed and the entire current of air is broken up into numerous eddies.

In an important paper in which he discusses the significance of the external nose for the respiratory air current, van Dishoeck showed that the vestibulum influences respiration in at least four ways: (1) cleansing of the inspired air, (2) influencing direction of in- and expiratory air flow through the nose, (3) facilitating the respiratory air flow, (4) the ostium internum as a "nose valve" influences the intranasal pressure to a considerable degree. In reviewing the function of the ostium internum van Dishoeck arrives at the following conclusion: "The fact that the ostium internum plays a major role in regulating the pressure in inspiration shows that breathing difficulties in many instances are not caused by septum deviations and hypertrophic turbinates, but by abnormally built vestibula or ostia interna. In these cases, submucous resections and conchotomies are inefficient if not accompanied or preceded by regulation of the vestibulum and ostium."

Wells likewise concludes that it is not difficult to see that the conformation of

the external nose and the size and position of the nostrils are essential determining factors in modifying the air current. Downward directed nostrils tend to raise the height of the curve and slow the current; upward tilted or forward directed nostrils tend to lower its height and accelerate the current.

Among the numerous lessons to be learned from these laboratory observations there is one which is especially pertinent to our purpose, namely, that unless the function of the external nose is taken into consideration much of the nasal surgery, such as resection of a turbinate or straightening out a deviated nasal septum must end, in many instances, in therapeutic failure. Altering the shape, size or length of the nose, in other words, rhinoplasty may be what is required to obtain relief. Often, both types of surgery must be instituted before permanent relief can reasonably be effected.

#### INDICATIONS

There is at present sufficient evidence, both clinical and experimental, to consider rhinoplasty not only as a cosmetic procedure but a definite therapeutic measure to be undertaken for the relief of various pathologic processes; specifically, the following conditions have been relieved by the correction of nasal malformations:

1. *Malformed Tips, Especially with Elongated, Unbalanced Nasal Ostia and Slit-like Nostrils.* That subluxation of the septum disturbs the respiratory function of the nose has long been known. Converse and Cinelli recently published very interesting and instructive papers calling attention to the importance of the reconstruction of these nasal malformations in order to establish good breathing.

When a patient with an elongated nose presents himself, he himself frequently calls attention to the fact that when he lifts the tip of his nose his breathing improves. This type of nose must be shortened. (Figs. 1 and 2.)



FIG. 1. Elongated tip, before operation.



FIG. 2. Appearance of patient in Figure 1 after operation.

2. *Hypertrophied columella* (Figs. 3 and 4) when reduced surgically, also promotes easier breathing and helps to bring about

either cotton rolls on each side of the nose or, better still, with a light metal splint plastered down with adhesive.



FIG. 3. Hypertrophied columella.



FIG. 4. Hypertrophied columella.

an air current which is more correct physiologically.

3. *Laterally deviated nose*, a very common nasal deformity resulting from an old fracture of the nasal bones, or the nasal septum, is frequently responsible for nasal dysfunction. A submucous resection, no matter how well performed, will in most instances fail to bring about satisfactory results unless the old fracture of the external nose is likewise corrected. (Figs. 5 and 6.)

At this point, the importance of prophylactic treatment of nasal deformities should be emphasized. Although in most instances the defects are congenital, there are, nevertheless, a considerable number caused by nasal injuries, particularly fractures incurred most often in early life. If treated at the time of accident, minor manipulation will usually suffice to replace the broken bones which can be held in position with

Metzenbaum calls attention to nasal injuries received at birth. These injuries, he states, cause not only impairment of breathing but also difficulty in nursing. He recommends re-establishment of anatomic structures chiefly by resetting of the dislocated septal cartilage, as early as the fourteenth postnatal day. He also deprecates the advice frequently given that "the child will outgrow it" or "not to do anything until the age of 16 or 18 years when the nose attains its full development so as not to injure a growing center, as this may hinder the development of this part of the nose."

4. Though numerous theories have been advanced as the etiology of *atrophic rhinitis*, the cause of this disease is essentially unknown; hence no positive and lasting cure has so far been advanced with any form of therapy. The one fact definitely outstanding is that practically all



FIG. 5. Lateral deviation of nose due to fracture before operation.



FIG. 6. Appearance of patient in Figure 5 after operation.

patients suffering from atrophic rhinitis present themselves not only with excessively roomy nasal chambers but also with unusually wide nasal bridges. It has long been known that reduction of the caliber of the nasal chamber has relieved these sufferers with what almost amounts to a cure. Numerous procedures have been recommended for the purpose of achieving this end, the simplest being that of injecting paraffin into the submucosa of the septum. However, since the dangers of paraffinoma are now well known, this method has been abandoned. Implants of cartilage, bone or ivory have also been used.

Of the narrowing operations those of Lautenslager, Wachsberger and Halle's modification of the Borries technic have been employed. All of the above operations are considerably difficult. Frequently, when patients are apprised of this, they refuse to submit to surgery.

Since rhinoplasty itself reduces the air spaces within the nose, rhinitis sicca and even atrophic rhinitis may be subjected to this type of operation with gratifying results. (Figs. 7 and 8.)

5. *Anosmia* is usually classified as either respiratory or essential in character. The respiratory type, according to Thompson, is caused by misdirection of the air current due to alteration or destruction of the alae narium which allows the air to be drawn in along the floor of the nose instead of reacting to the olfactory region. It is not improbable that olfaction can be materially affected by the air current, excepting in the case of obstruction necessitating an actual deflection of the stream of air. In this respect, I can corroborate the observation of Halle and Cinelli that either improvement occurs or that the sense of smell completely returns following rhinoplasty. This probably results from changing the air currents in the direction of the olfactory region.

6. Although one must guard against over enthusiasm, I may state that others as well as myself have had the satisfaction

of seeing certain types of *frontal headaches* disappear after rhinoplasty. The only possible explanation for such an occurrence is offered by Burnham who states that in many instances the headaches arise from irritation of the anterior ethmoidal nerve (a branch of the trigeminus) on the lateral nasal wall. In most cases no sinus disease is present, nor are any of the usual signs of nasal involvement to be discerned.

7. *Tumors of the External Nose.* (Figs. 9 and 10.)

#### CONTRAINDICATIONS

Before undertaking any surgical alteration in the shape of the nose, it is essential that the surgeon ascertain that no active purulent or polypoid disease exists in either the frontal, sphenoidal or ethmoidal region. These conditions must first be treated and eradicated, and sufficient time allowed to elapse for complete healing before the plastic surgery is begun. Diseases of the maxillary sinuses, inactive and under control, are no contraindication to rhinoplasty. Of course, the usual systemic contraindications apply here, too.

#### COMMENT

It is not my intention to convey, in this paper, the impression that in rhinoplasty we have discovered a new panacea for most if not all nasal dysfunctions; neither do I desire to exaggerate in the least the benefits which derive from altering the shape of the nose or the nostrils. However, sufficient experimental as well as clinical evidence is accumulating to prove that in some individual cases rhinoplasty must be considered for functional reasons, regardless of the cosmetic indications. Deformities of the external nose or nares, or both, are frequently responsible for chronic nasal complaints, and no intranasal surgery is complete without reconstructing the frame of the nose itself. It is believed that the benefits result mainly from re-establishing more normal intranasal air currents.



FIG. 7. Atrophic rhinitis in patient with a wide nasal bridge before operation.



FIG. 8. Appearance of patient in Figure 7 after operation.



FIG. 9. Paraffinoma of nose before operation.



FIG. 10. Appearance of patient in Figure 9 after operation.\*

\* Illustrations appeared originally in the *Tr. Sec. Laryngol., Otol. & Rhinol.*, A. M. A., 1941.

## CONCLUSIONS

1. A review of experimental and clinical studies both in America and abroad is given. Although some of this work was not done specifically to prove the value of rhinoplasty, it nevertheless supports and substantiates many of the functional indications for rhinoplasty.

2. Rhinoplasty has definite therapeutic as well as cosmetic indications.

3. In order to obtain good functional results, in a certain percentage of cases, correction of nasal deformity must be accomplished simultaneously, or prefer-

ably after eradication of the specific pathologic process.

4. A closer examination of recent experimental work may explain why submucous resection or turbinectomy fails to give relief in many instances.

5. Rhinitis sicca and, to a lesser extent, atrophic rhinitis, are definitely benefited by rhinoplasty due to reduced space of the nasal chambers.

6. Interrelationship between rhinoplasty and rhinology is once more reviewed. The necessity for the rhinologist to know rhinoplastic technic and its indications, and vice versa is stressed.



A HUNTERIAN chancre may appear on the lip. Unlike a similar lesion on the genitals, the neighbouring lymphatic glands become *greatly* enlarged.

From "A Short Practice of Surgery" by Hamilton Bailey and R. J. McNeill Love (H. K. Lewis & Co. Ltd.).

# REGIONAL ENTERITIS\*

## CASE REPORTS

LAURENCE SIDNEY FALLIS, M.D.

Surgeon-in-Charge, Division of General Surgery, Henry Ford Hospital  
DETROIT, MICHIGAN

THE most interesting feature of this new clinical entity is the apparent rapid increase in the incidence of the disease. It is almost certain that the disease is on the increase, for prior to 1933, even discounting the occasional case that was indexed as tuberculosis, benign granulomas of the small intestine were exceedingly rare tumors. At the Henry Ford Hospital approximately 195,000 patients were registered during a fifteen-year period, up to January 1, 1933, and of this number only one case of granuloma of the small intestine and seven cases of tuberculosis of the small intestine were indexed. During the past ten years, 1933 to 1943, out of 180,000 new patients there have been twenty-seven undoubted cases of regional enteritis as proved by operation and an additional five cases diagnosed on the interpretation of history and x-ray findings, but not yet submitted to operation. On the basis of operative cases alone the contrast is convincing enough to prove that the disease is definitely more prevalent than previously believed.

This review covers the cases studied during a ten-year period, January 1, 1933 to January 1, 1943.

### AGE OF PATIENT

Regional enteritis is predominately a disease of young people. In our series as outlined in Table I, over 80 per cent of the cases occurred in patients under forty years of age, and over 50 per cent occurred in the third and fourth decades between the ages of nineteen and thirty-nine. The youngest

patient was aged nine and the oldest sixty-nine.

### SEX

The ratio of males to females was 4:3 as shown in Table II. This confirms Crohn's<sup>1</sup> opinion that regional enteritis has a preference for male patients. His patients showed a proportion of 3:2.

TABLE I  
AGE BY DECADES  
32 Cases Regional Enteritis

Decade	Age	No. Patients	Percentage
1	0-9	1	3.1
2	10-19	5	15.6
3	20-29	10	31.3
4	30-39	10	31.3
5	40-49	3	9.4
6	50-59	2	6.2
7	60-69	1	3.1
Totals....	.....	32	100.0

TABLE II  
SEX  
32 Cases Regional Enteritis

Sex	No. Patients	Per-centage
Male.....	18	56.2
Female.....	14	43.8
Total.....	32	100.0

### RACE

In contrast to some of the earlier reports<sup>2</sup> on regional enteritis,<sup>3</sup> none of our patients was of Hebrew extraction. All were Caucasians.

\* From the Department of Surgery, Henry Ford Hospital, Detroit, Michigan.

## DURATION OF SYMPTOMS

The acute cases of which there were ten (31.3 per cent), all had symptoms of recent origin and in none was the duration greater than two weeks. The eleven patients with obstructive symptoms indicating the chronic nature of their disease admitted having gastrointestinal symptoms over periods varying from one month to five years. Approximately one-third of the total series admitted having had symptoms for longer than two years. Table III groups the

TABLE III  
DURATION OF SYMPTOMS  
32 Cases Regional Enteritis

Duration	No. Patients	Per- centage
2 weeks or less.....	10	31.3
1 month-6 months.....	4	12.4
6 months-1 year.....	5	15.6
1 year-2 years.....	3	9.4
2 years-5 years.....	10	31.3
	32	100.0

patients in respect to the duration of their symptoms.

## SYMPTOMATOLOGY

*Obstructive Manifestations.* The predominating symptoms are outlined in Table IV. Here it is seen that obstructive

TABLE IV  
SYMPTOMATOLOGY  
32 Cases Regional Enteritis

Predominating Symptom	No. Patients	Per- centage
Obstruction.....	11	34.4
Simulating acute appendicitis.....	13	40.7
Diarrhea.....	4	12.4
Fistula.....	3	9.4
Hemorrhage.....	1	3.1
	32	100.0

symptoms were outstanding in one-third of the patients. Acute intestinal obstruction is

relatively rare though one of our patients operated upon during the acute stage of the disease manifested all the signs of acute obstruction. More commonly the evidence is that of chronic obstruction such as intermittent colicky abdominal pains, borborygmi, etc. A tumor mass was palpable in 18 per cent of our patients.

*Symptoms Simulating Acute Appendicitis.* Evidence of acute pathological involvement limited to the right lower quadrant led the observer to diagnose and to operate for acute appendicitis in two-fifths of the patients, and in twelve of the thirteen patients the appendix was removed without untoward development, in spite of involvement of the terminal ileum.

*Fistula Formation.* Though none of the patients on whom we performed appendectomy during the acute stage of terminal ileitis developed fistula, this complication was seen in three patients of this series, both operated upon elsewhere. One other fistula was observed following an emergency operation for ectopic gestation, but the ileal involvement was not discovered until operation for cure of the fistula was undertaken. Recovery followed resection of the ileocecal segment, though the patient subsequently developed ulcerative colitis for which jejunostomy and colectomy has been necessary. Stafford has commented on this association of regional enteritis with ulcerative colitis.<sup>5</sup> We have been intrigued by finding so few examples of fistula (9.4 per cent) secondary to regional ileitis, among our patients, while most authors<sup>1</sup> have<sup>3</sup> commented<sup>4</sup> upon the frequency of this complication in their patients. Crohn<sup>1</sup> states that fistula formation is the outstanding characteristic of regional enteritis. He found forty-three fistulas (39.1 per cent) in 110 personally observed cases. Hurst<sup>6</sup> on the other hand has had experience similar to ours, for he did not observe a single instance of this complication until January, 1939, when he described three cases of regional enteritis with fistula and stated that they were the first recorded in England.

**Diarrhea.** Diarrhea was an outstanding symptom in 12.4 per cent of our patients. Frequent stools are indicative of the ulcerative stage of the disease though other evidence of inflammatory reaction may be wanting. This symptom denotes the subacute phase of the disease.

**Hemorrhage.** Bleeding is a rare symptom of regional enteritis. This symptom received scant mention in most case reports, in fact, certain authors even comment on its absence. Considering that mucosal ulceration is of frequent occurrence, one might expect that hemorrhage would be a common symptom. The finding of occult blood has been reported occasionally<sup>6</sup> but I have been able to find only one reference in the literature to gross hemorrhage in regional enteritis. Bargen<sup>7</sup> (1938) at a staff meeting of the Mayo Clinic mentions massive hemorrhages in discussing the diagnosis of regional enteritis. A detailed case report<sup>8</sup> of one of our patients who manifested the symptom of profuse intestinal hemorrhage has been described.

TABLE V  
LEUCOCYTOSIS  
32 Cases Regional Enteritis, Henry Ford Hospital

White Blood Cells per Cu. Mm.	No. Patients	Percentage
4,000-8,000	12	37.6
8,000-12,000	11	34.4
12,000-15,000	4	12.4
15,000-20,000	5	15.6
	32	100.0

**Previous Appendectomy.** The statement has often been made that an appendectomy scar is one of the physical findings in a patient with regional enteritis. Our patients were no exception to the rule for thirteen (40.7 per cent) of the thirty-two patients had been subjected to appendectomy. All five of the patients treated medically had previous appendectomies, six of the twelve patients on whom resection was performed had their appendix removed elsewhere and the same was true

of two of the three patients who were treated by short circuiting operations.

**Leucocytosis.** The relative mildness of the infection in regional enteritis is emphasized in Table V for in 42.9 of the patients the polymorphonuclear count did not rise above 8,000 and in only 21.4 per cent was it above 12,000.

#### PREOPERATIVE DIAGNOSIS

As Table VI reveals a correct diagnosis was arrived at in only one-third of our

TABLE VI  
PREOPERATIVE DIAGNOSIS  
32 Cases Regional Enteritis

Diagnosis	No. Cases	Per-cent-age
Regional enteritis.....	11	34.4
Acute appendicitis.....	10	31.3
Intestinal obstruction.....	7	21.9
Cause unknown		
Carcinoma		
Intestinal fistula.....	2	6.2
Intestinal hemorrhage.....	1	3.1
Pelvic inflammatory disease.....	1	3.1
Total patients operated upon.....	27	100.0
Not operated upon.....	5	
	32	

patients. Cases simulating acute appendicitis will always remain a diagnostic problem, difficult of solution because most of these patients will continue to be subjected to emergency operations. In the light of our present knowledge it is unlikely that the diagnosis of regional enteritis will continue to be overlooked in obstructive and fistula cases as it was in this series, largely because the observer was not thinking of this new clinical entity. The diagnosis in our one case with signs of massive intestinal hemorrhage was missed completely because we were not aware at that time that profuse bleeding occurred in regional enteritis. One case was diagnosed as pelvic inflammatory disease because of the finding of a pelvic mass which at operation proved to be due to gravitation into the pelvis of involved loops of ileum.

Increased knowledge of the clinical manifestations of regional enteritis will lead to a higher incidence of positive preoperative diagnosis.

#### OPERATIONS PERFORMED

The various operations performed are tabulated in Table VII. If the disease is

TABLE VII  
OPERATIONS PERFORMED  
32 Cases Regional Enteritis

Type Operation	No. Patients	Per-cent-age	Deaths	Mor-tal-ty, Per Cent
Primary resection.....	16	43.2	0	0
Mickulicz resection.....	2	5.4	0	0
Enterico-anastomosis.....	3	8.2	2	66.7
Appendectomy.....	12	32.4	0	0
Excision of fistula.....	1	2.7	0	0
Release of intestinal adhesions.....	1	2.7	0	0
Abdominal exploration.	2	5.4	0	0
Total operations.....	37	100.0	2	5.4

encountered in the acute stage the abdomen should be closed at once. The surgeon should refrain from handling the intestine and should not seek to salve his surgical conscience by performing appendectomy. This advice is proffered in spite of the fact that twelve of our own patients had appendectomy performed during the acute phase of the disease without the development of any complication. On the basis of our own experience eighteen resections with no deaths, primary resection appears to be the operation of choice in the subacute and chronic stages of regional enteritis. Resection should include as wide removal of the adjacent mesentery as is done in the operation for malignant disease. Inspection of the entire small intestine is necessary to avoid overlooking an additional lesion. Short-circuiting operations are not much in favor at the Henry Ford Hospital for our only deaths occurred in patients on whom this palliative proce-

dure was performed. In one patient the operation was ill-advisedly attempted during the acute stage of the disease in a misdirected effort to control acute intestinal obstruction, and in the other a resection had been projected but was abandoned in favor of enterico-anastomosis when the patient was found to be standing the operation poorly. This patient died of circulatory collapse, the exact mechanism of which remains unknown but perhaps the operation was attempted too soon after an acute flare-up of the disease which had occurred ten days before. Theoretically, the short-circuiting procedure has little to commend it, since the diseased area is left where it can act both as a focus for local extension of the disease and for the production of toxins. Moreover intestinal resection using the modern aseptic end-to-end anastomotic technic requires but little additional operating time and is only slightly more productive of shock than either the short-circuiting or the exteriorization procedures. Multiple resections in which short-circuiting may be the first stage have a definite place in the management of external or internal fistula secondary to regional enteritis. The mortality for the series was two deaths in thirty-seven operations (5.4 per cent).

#### PATHOLOGY

The pathology of regional enteritis has been adequately described.<sup>1</sup> I shall, therefore, comment on only two points which appear significant: First, we have been impressed by the absence of adhesions even in advanced stages of the disease. This was also a finding of note in our patients who required more than one resection. The smooth, glistening appearance of the visceral peritoneum at the site of anastomosis and the absence of even omental adhesions to either the intestine or repaired mesentery were in striking contrast to the usual findings after previous laparotomies for other conditions. The other impressive point is the enormous size of the mesenteric lymph nodes draining the involved area.

## LOCATION OF THE LESION

Crohn's original<sup>2</sup> impression that the disease was limited to the terminal ileum has been modified because of numerous reports of involvement of the jejunum and cecum. The terminal ileum nevertheless is affected in the vast majority of cases. In our series as indicated in Table VII the

TABLE VIII  
LOCATION OF THE LESION  
32 Cases Regional Enteritis

	No. patients	Per-cent-age
Terminal ileum alone.....	25	78.2
Terminal ileum and cecum.....	3	9.4
Terminal ileum and jejunum.....	1	3.1
Upper ileum and lower jejunum....	1	3.1
Multiple areas ileum and jejunum.	1	3.1
Upper jejunum.....	1	3.1
	32	100.0

terminal ileum was implicated in over 90 per cent of the patients, and in 78.2 per cent it alone was the site of the lesion. In two instances the cecum was invaded by the disease and in four patients it had spread to the jejunum. The lesions were confined to the jejunum in only one instance. Single areas were involved in twenty (80.0 per cent) of the twenty-seven patients treated by operation. Three patients presented two areas of disease, one three areas, one six areas, and in two the process was so diffuse as to preclude resection.

## FOLLOW-UP

The fate of the patients observed is noted in Table IX. Considering first the patients with acute regional enteritis on whom appendectomy was performed, we find that of the twelve cases, ten patients are well, one returned for resection of the involved area, and one required operation for relief of obstruction due to adhesions. The ten patients who are presumably well may

simply be in a quiescent stage of the disease; certainly we cannot say that they are cured. Of the thirteen patients on whom resection was performed, four (30.8 per cent) suffered from recurrence and required further resection. One of these patients had a second recurrence, necessitating a third resection. All three patients on whom short-circuiting operations were performed are dead, two were hospital deaths and the other died at home some months later. Strangely enough the patient on whom the intestinal fistula was excised, healed

TABLE IX FATE OF THE PATIENTS 32 Cases Regional Enteritis	
12 appendectomies.....	8 A & W no further trouble 1 subsequent resection 1 release of intestinal adhesions 2 mild symptoms persist
13 resections.....	9 remained well 1 required two subsequent resections 3 required further resection
3 entero-anastomosis.....	2 postoperative deaths 1 died at home later
1 excision of fistula.....	well
2 abdominal exploration..	1 multiple lesion operation impossible fairly well under medical treatment 1 entire ileum involved except terminal 5 inches symptoms continue
5 not operated.	

promptly and has had no further trouble in spite of the presence of definite disease in the terminal ileum. The two patients on whom no operations were performed because of the extensive nature of the disease have remained fairly well under a medical regimen. The five patients on whom a definite diagnosis of regional enteritis has been made are maintaining fair health under medical treatment. We believe, however, that they are potential candidates for surgical intervention.

## SUMMARY AND CONCLUSIONS

1. The incidence of regional enteritis is apparently on the increase.
2. Males were affected more frequently than females in the ratio of 4:3.

3. Eighty per cent of the cases occurred in patients under forty years of age.

4. Thirteen (40.7 per cent) of the thirty-two patients reported had previous appendectomy.

5. In one patient a reported massive intestinal hemorrhage was the outstanding symptom.

6. A correct preoperative diagnosis was made in only one-third of the patients.

7. Resection is the operation of choice.

8. The mortality for the series was two deaths in thirty operations (6.7 per cent). There were no deaths in eighteen resections.

9. The terminal ileum was involved in 90 per cent of the cases.

10. Thirty per cent of the patients on whom resection was performed suffered

from recurrence and required subsequent resection.

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# REFRIGERATION ANESTHESIA OF THE EXTREMITIES\*

## A STATISTICAL STUDY

S. THOMAS GLASSER, M.D. AND WALTER L. MERSHEIMER, M.D.  
NEW YORK, NEW YORK

SINCE June, 1941, the Surgical Service of the Metropolitan Hospital has employed refrigeration anesthesia for eighteen amputations through the thigh. It is our purpose to compare the results and mortality with those reported elsewhere. In making this comparison it would be a redundancy to repeat a description of the original work of Allen.<sup>1-5</sup> The only large series (fifty-seven major amputations) as reported by Crossman, Ruggiero, Hurley and Allen<sup>6,7</sup> gives a case (45) mortality rate of 15.5 per cent and an amputation (57) rate of 12.3 per cent. The cases reported are typical of the admissions to New York City hospitals for the indigent.

Our series comprises gangrene of the lower extremity secondary to diabetic and arteriosclerotic peripheral vascular disease. Although we have not employed refrigeration for traumatic injuries and infection, this has been used successfully by McElvenny<sup>8</sup> and Duncan and Blalock.<sup>9</sup> It might be of interest, at this point, to mention the fact that we have successfully used refrigeration anesthesia without the tourniquet for incision and drainage of the foot and to perform local excision such as removal of small tumors. Primarily, our object in using refrigeration anesthesia was to eliminate the anesthesia hazard in poor risk patients, especially the aged. We are not entirely convinced that refrigeration should supersede a properly administered low spinal anesthesia. The high mortality as published in all clinics for amputation in the type of cases which we are describing has probably been due to one of the following: (1) improper preoperative preparation, particularly control of diabetes

when present; (2) failure to select the proper anesthetic agent; (3) prolonged operative time and the utilization of a "plastic" amputation in the poor risk patient when a simple circular or modified circular amputation should be done; (4) improper postoperative care, particularly failure to encourage early (twenty-four to forty-eight hours) movement (out of bed) and thus circumvent pulmonary complications such as hypostatic pneumonia and pulmonary embolism.

Femoral vein ligation, preliminary to amputation, as a prophylactic measure against postoperative embolism—a frequent cause of death in these cases—has not received sufficient emphasis and will be the basis of a subsequent report. Suffice it to say, that in the present series, there was no pulmonary embolus in those cases in which this procedure was utilized preliminary to amputation. The only mention of this method in the literature is that of Veal.<sup>10</sup> In addition, the value of this procedure to improve the collateral circulation has been reported by Glasser and Lesser.<sup>11</sup>

The technic that we employ varies but slightly from that of Allen and his co-workers.

1. Diet is permitted until the patient is ready for the operating room.
2. The thigh and leg is properly prepared by shaving, soap and water cleansing; ether and alcohol.
3. A narrow gum rubber tourniquet is applied sufficiently tight to occlude the blood supply at a level three inches above the proposed site of amputation. Two turns are usually sufficient. A rubber sheet and a blanket are placed under the ex-

\* From the Department of Surgery, New York Medical College, Flower and Fifth Avenue Hospitals and Metropolitan Hospital; Dr. Louis R. Kaufman, Director.

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TABLE I  
SUMMARY OF REFRIGERATION ANESTHESIA CASES

Name	Case No.	Age	Sex	Race	Diagnosis	Patient's Condition	Operation	Comments	
J. L.	330	58	F	B	General Bilat., pulm. tbc., of larynx, diabetes mellitus	Diabetic gangrene of left leg and endarteritis obliterans; diabetic gangrene of right leg	Poor	Left mid thigh amputation 3-7-42; right mid-thigh amputation 3-14-42	Right stump healed; left stump with protrusion of femur required revision; died 4-25-42 (42nd day) of pulmonary tbc.
S. W.	747	57	F	W	Diabetes mellitus, coronary occlusion (postmortem diagnosis)	Diabetic gangrene of left leg and heel	Poor	Left femoral vein ligation (local anesthesia) 6-13-41; left low thigh amputation 7-19-41	Marked improvement and control of infection following femoral vein ligation until 6-30-41 when stump broke down; died 8-18-41 (30th day)—myocardial failure after coronary occlusion
L. C.	693	72	F	W	Arteriosclerotic heart disease; auricular fibrillation; thrombosis of right iliac and femoral arteries	Gangrene right leg	Poor	Femoral vein ligation and right arterectomy (local anesthesia) 7-2-41; right midthigh amputation 7-5-41	Patient out of bed; embolism to left extremity 7-27-41 (22nd day); stump healed; sudden death (7-29-42)—24th day due to embolism (site unknown)
E. J.	735	67	F	W	Arteriosclerotic heart disease	Gangrene left leg	Poor	Left midthigh amputation 8-4-42	Postoperative shock and semi-coma for 48 hours; died 8-13-42 (9th day) pulmonary embolism (postmortem diagnosis)
L. R.	198	46	F	W	Diabetes mellitus; uremia	Gangrene right leg with infection	Poor	Incision and drainage right foot (refrigeration anesthesia) 2-28-42; right low thigh amputation 3-9-42	No tourniquet for incision and drainage; operated on request of Medical Service to control toxemia. N. P.N. 200; urea N. 140; creatinine 3.1; CO <sub>2</sub> 45; bl. sugar 450; died 3-16-42 (1 day survival); uremic coma
I. G.	871	82	F	W	Diabetes mellitus; arteriosclerotic heart disease; hypertension	Gangrene right leg	Poor	Right femoral vein ligation 8-15-41; right low thigh amputation 3-9-41	Died 10-5-41 (5th day) cause unknown
A. G.	on* ward	67	M	W	Diabetes mellitus; hypertensive cardiovascular disease	Gangrene right leg	Poor	Right femoral vein ligation 2-17-42; right low thigh amputation 3-2-42	Wound healed; patient in hospital waiting for prosthesis
E. L.	122 576	78	F	W	Hypertensive cardiovascular disease; auricular fibrillation; left hemiplegia; ununited fracture of neck of femur; infected wound of thigh	Gangrene left leg	Fair	Femoral vein ligation 6-7-41; left low thigh amputation 6-9-41	Healed by primary union; incomplete anesthesia due to faulty application of tourniquet

TABLE I (Continued)

Name	Case No.	Age	Sex	Race	Diagnosis		Patient's Condition	Operation	Comments
					General	Local			
J. S.	128 248	60	M	W	Diabetes mellitus; arteriosclerotic heart disease; furunculosis of buttock; latent syphilis	Gangrene right leg	Fair	Right femoral vein ligation 3-30-42; right low thigh amputation 4-4-42	Healed by primary union; discharged 5-6-42
E. R.	on* ward	79	F	B	Arteriosclerotic heart disease	Gangrene right leg	Fair	Right femoral vein ligation 4-22-41; right low thigh amputation 11-25-41	Healed by primary union, severe vesiculation and blebs as a complication of refrigeration
M. Mc.	127 195	65	M	W	Diabetes mellitus; arteriosclerotic heart disease	Gangrene right leg	Fair	Right femoral vein ligation 2-9-42; right low thigh amputation 3-2-42	Healing by primary union
N. P.	387	88	M	W	Arteriosclerotic heart disease; cardiac failure	Gangrene left leg	Poor	Left midthigh amputation 5-8-42	Died 5-11-42 (3rd day) of arteriosclerotic heart disease
M. K.	129 588	66	F	W	Diabetes mellitus	Gangrene left leg. Infection left foot	Fair	Refrigeration anesthesia without tourniquet for incision and drainage of left foot 5-5-42; left low thigh amputation 6-9-42	Slow healing, incomplete anesthesia due to faulty technic; discharged 6-28-42
B. W.	129 837	62	F	W	Diabetes mellitus; ulcer left heel	Gangrene left leg	Fair	Left low thigh amputation 6-4-42	Healing by primary union
P. A.	129 868	77	M	W	Hypertensive cardiovascular disease; generalized arteriosclerosis	Gangrene left leg	Fair	Left low thigh amputation 6-4-42	Healing by primary union
J. H.	132 542	59	M	W	Diabetes mellitus; generalized arteriosclerosis; thrombosis right femoral artery	Gangrene left leg	Fair	Left femoral vein ligation 9-29-42 and arterectomy; left low thigh amputation 9-30-42	Healing by primary union
A. B.	on* ward	58	M	W	Diabetes mellitus; generalized arteriosclerosis; cardiac compensation; infarct anterior wall (EKG); pulmonary congestion	Gangrene left leg	Fair	Left low thigh amputation 11-5-42	Patient still on ward; wound healing well (6th day)

Note: 1. All femoral vein ligations performed under local anesthesia. 2. All amputations were of guillotine type; rapidly performed—average time, 10 minutes.  
 \* Patients on ward have no case number until discharged from hospital.

tremity. The extremity is then completely surrounded by a layer of ice three inches in depth, extending from the toes to a point three inches above the tourniquet. The ice is cracked to the size of walnuts. The extremity encased in ice is then surrounded by the rubber sheet and blanket.

4. Preoperative medication is given as for any local anesthesia.

5. The minimum time necessary for refrigeration: thigh—two hours; leg—one and one-half hours; lower part of leg, ankles, toes—one hour.

6. For incision and drainage an identical procedure is followed but the tourniquet is not applied. Refrigeration anesthesia without the use of tourniquet has proved very satisfactory for many patients requiring incision and drainage or local excision. It is of interest to note that the tourniquet was applied 10 cm. above the knee completely occluding the circulation and the extremity refrigerated for six hours in a patient who had a simple incision and drainage of a plantar infection of the foot. This error caused grave concern as to viability of the extremity. However, the patient fully recovered and the only untold complication was severe vesiculation of the extremity.

We do not find it necessary to apply ice prior to the application of the tourniquet as suggested by Allen et al. in order to eliminate pain. It should again be emphasized that the ice is not removed until the patient has been placed on the operating table and the operating team is prepared. The ice is then removed and the limb draped. We do not find it necessary to ice the instruments. The tourniquet should not be released until the major blood vessels are secured and the stump is ready for closure. We have omitted immobilization of the stump with a plaster of Paris splint. Unless obvious infection has been encountered the use of ice bags about the stump postoperatively has been eliminated. The use of ice bags about the stump postoperatively may be advantageous if infection is present. Wound healing does not

appear to be delayed when the postoperative use of ice bags is eliminated.

A tabular analysis of the individual case reports is presented (Table 1). The gross mortality in our series is 38.8 per cent. This appears high but in an analysis of the deaths only two cases could be attributed to operative intervention, correcting the operative mortality to 11.1 per cent. The fatalities ruled out in the corrected mortality are, (1) bilateral pulmonary tuberculosis; (2) pulmonary embolus (which might have been avoided by preliminary femoral vein ligation); (3) death due to coronary occlusion; (4) embolism—site unknown; (5) diabetic and uremic coma.

#### CONCLUSIONS

Refrigeration anesthesia is of value in (1) selected poor risk patients for major amputations; (2) prevention of shock and reduction of infection in traumatic injury; (3) incision and drainage or excision without the use of the tourniquet.

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# ABSORPTION RATES OF SULFANILAMIDE

## OBSERVATIONS UNDER VARYING PATHOLOGICAL CONDITIONS

BENJ. I. GOLDEN, M.D.

Diplomate of the American Board of Surgery

ELKINS, WEST VIRGINIA

WITH the introduction of sulfanilamide into tissues and cavities of the body there has arisen many controversial statements, not as to the value of chemotherapy in surgery but the mode of application. Due to scientific conservatism many are loathe to withdraw from the usual routes of drug administration. Others adhere to a combined method in the belief that prolonged application of the bacteriostatic action will give the best results.

In this communication, we will not discuss the value of the drug as an adjunct to surgical armamentarium. This paper shall be limited entirely to one drug, sulfanilamide, for the following reasons: First, it is apparently the most soluble in body fluids, not "caking" like sulfathiazole; second, it is probably the best of the sulfa group to be used as a general all purpose drug; third, we believed we should limit this experimental work to one drug, because the work being done on the human would not involve undue risk; and lastly, a more intensive study should be made on a definite sulfa drug, so that the mind would not be confused with the many conflicting or premature reports that are being published concerning new derivatives.

In this work we established a constant dosage of 8 Gm. of the sulfanilamide powder, regardless of age or condition. The drug was not sterilized but used just as it came from the bottle. When placed into a cavity the wound edges were retracted and the operating room supervisor poured the drug over the presenting area, all packs and mechanical restrainers having been removed previously. There was no

effort to spread the drug. This we oppose on the grounds that infection can also be spread; and since the drug goes quickly into solution in body fluids normally, dispersion of the saturated fluids by visceral motion, diffusion and muscular motion obtain the same results without danger of needless contamination. This is not true of sulfathiazole, which in our hands, has clumped and actually become encysted. Blood levels were taken at two-hour intervals until the peak was reached and the curve was on the descent. Then four to six-hour levels were taken as conditions warranted. All wounds were closed primarily when possible, even though we were certain there would be a residual abscess which would require secondary attention. One death is recorded. This was due to an embolus on the day of discharge from the hospital, and, therefore, cannot be analyzed in this discussion. These patients all received regular postoperative care for the type of case involved, as though the drug were not used. None received more than the one direct dose. All received early feeding. In no case was there excessive nausea or vomiting that could be attributed to the drug. Blood counts fluctuated within normal range of the disease, regardless of the presence of the drug. The histories present a group of typical cases from which our deductions and observations will be made.

### CASE REPORTS

CASE I. No. 41536. A male, age seventeen, was diagnosed as having suppurative appendicitis with free purulent fluid in the abdominal cavity. Appendectomy was performed, 8 Gm. of sulfanilamide were placed in the abdominal

cavity and primary closure performed. A small wound infection followed with serous drainage. The rates of absorption of the drug were as follows: two hours, 3.0 mg. per cent peak; four hours, 1.8 mg. per cent; sixteen hours, 3.0 mg. per cent peak; twenty-eight hours, 2.4 mg. per cent; forty hours, 2.2 mg. per cent; 148 hours, 0 mg. per cent.

**CASE II.** No. 41474. A male, age fifteen, had acute suppurative appendicitis and free purulent abdominal fluid with a colon odor. Appendectomy was performed and 8 Gm. of sulfanilamide applied. A cigarette drain was inserted and there was a stormy convalescence for seventy-two hours. On the seventh day cyanosis developed. The patient was hospitalized twenty-five days and recovered completely. The wound had healed on discharge. The absorption peak at seventy-two hours was 4 mg. per cent; ninety-six hours, 3.4 mg. per cent; 120 to 168 hours 2.0 mg. per cent; 192 hours, 2.2 mg. per cent; 240 hours, 0 mg. per cent.

**CASE III.** No. 41496. A male, age fifty-two, had acute purulent appendicitis with loculating abscess to the posterior peritoneal wall. Appendectomy was performed and the appendix ruptured while being dissected from the posterior wall. Primary closure was employed. Eight Gm. of sulfanilamide were deposited in the operative site. The patient was hospitalized nine days. Absorption rates were as follows: four hours, 3.2 mg. per cent; six hours, 2.0 mg. per cent; eighteen hours, 2.5 mg. per cent; forty-two to fifty-four hours, 2.8 mg. per cent; 138 hours 0 mg. per cent.

**CASE IV.** No. 42198. A female, age thirty-three, had a left pelvic abscess following operative procedure for old subacute left salpingitis. Operation was performed and one small rubber tube was inserted for drainage. Eight Gm. of sulfanilamide were deposited in the operative site. Absorption rates were as follows: two hours, 1.2 mg. per cent; four hours, 3.2 mg. per cent, first absorption peak; six hours, 1.5 mg. per cent; eighteen hours, 3.0 mg. per cent, second absorption peak; forty-two hours, 1.0 mg. per cent; sixty-six hours, 1.8 mg. per cent; 114 to 138 hours, 1.0 mg. per cent; 162 hours 0 mg. per cent.

**CASE V.** No. 43774. A female age forty-two had a left ovarian cyst and uterine fibroid. The following procedures were carried out: Supravaginal hysterectomy, bilateral salpingec-

tomy, left oophorectomy and complete peritonealization. Sulfanilamide absorption rates were as follows: two hours, 2.4 mg. per cent; peak four hours, 4.2 mg. per cent; six hours, 3.2 mg. per cent; twenty-two hours, 3.2 mg. per cent; fifty-four hours, 0 mg. per cent.

**CASE VI.** No. 43899. The patient, a female age twenty-two, had varicosities of the broad ligament, grade II. The Baldy-Webster suspension operation was performed; the uterosacral ligaments were plieated and appendectomy was done (normal peritoneal histology). This operative procedure followed the technic recommended by Dr. Earl Craig of Philadelphia. Sulfanilamide (gr. 120) was used. The absorption rates were as follows: two hours, 4.2 mg. per cent; four hours, 4.6 mg. per cent; six to eight hours, 5.8 mg. per cent, absorption peak; twenty-two hours, 3.2 mg. per cent; thirty-four hours, 1.4 mg. per cent; forty-six hours, 1.0 mg. per cent; seventy hours, 0.4 mg. per cent.

**Comment.** These cases represent instillation of sulfanilamide into the lower half of the abdominal cavity. This portion of the abdomen, we have been taught to believe, is the area of greatest absorbability, and because of this, have used Fowler's position as an aid in treating peritonitis from any cause.

In the first three cases, the diagnosis of suppurative appendicitis is made with varying degrees of pathological processes. These are operating diagnoses, yet we find a marked variance in the peak absorption time and a definite irregularity as to the rate of absorption in the same patient.

The second three cases represent pelvic surgery. The first of these possibly should not be included because of the rubber drain in the pelvis, but it is evident that the drainage did not materially interfere since absorption proceeded as in the appendiceal cases in which there was massive disturbance of sufficient duration to impair the function of the peritoneum. On the other hand, case No. 43774 was a supposedly normal peritoneum, even though the condition was of long duration, absorption was comparatively rapid and the percentage high. Case No. 43899 had about the same

amount of surgery and visceral disturbance. Here the disorder was of a minor degree but we find the absorption rate high and the peak time about the same as the preceding case.

**CASE VII.** No. 43737. A female patient, age forty-five, had cholecystitis and cholecystectomy was performed. One hundred twenty gr. of sulfanilamide were packed into the gallbladder sulcus of the liver; the gallbladder bed was not sutured (practically a dry bed—sharp dissection); a small rubber tube drain was inserted to the common duct. Absorption levels were, four hours, 3.4 mg. per cent; six to eight hours, 3.8 mg. per cent, absorption peak; twenty hours, 2.2 mg. per cent; sixty-eight hours, 0 mg. per cent.

**CASE VIII.** No. 43739. This patient, a female, age forty-seven, had cholecystitis and cholelithiasis. Cholecystectomy was performed and the common duct explored. Common duct drainage was instituted and 120 gr. of sulfanilamide were used. Absorption rates were two hours, 2.2 mg. per cent; four hours, 2.2 mg. per cent; six hours, 3.2 mg. per cent, absorption peak; eight hours, 2.8 mg. per cent, ten hours, 3.2 mg. per cent, absorption peak; twenty hours, 2.5 mg. per cent; sixty-eight hours, 0 mg. per cent.

**Comment.** Here the absorption includes not only the upper abdomen, but the denuded liver bed, and possibly the lesser peritoneal cavity. It is interesting to note that the rate and peak are about the same. Tube drainage in both these cases was almost nihil.

All patients herein reported were operated upon under either spinal anesthesia (neocaine) or ether or a combination of the two, as in gallbladder surgery. No patient with the exception of the one mentioned in the case history, had distention, gastric or duodenal drainage, excessive nausea or vomiting, and all were fed within a postoperative period of six hours.<sup>1</sup>

**CASE IX.** No. 41791. A male, age thirty-one, married, had tuberculosis with abscess formation of the right testicle. Right orchidectomy was performed. Eight Gm. of sulfanilamide were implanted and primary closure was done. Absorption blood levels were as follows: two

hours, 0.5 mg. per cent, first peak; six hours, 2.8 mg. per cent; eight hours, a drop to 1.25 mg. per cent; sixteen hours, return to 2.6 mg. per cent; 160 hours, 0.8 mg. per cent.

**CASE X.** No. 41552. A male, fifty-six years old, had diabetes mellitus, cardiac decompensation and an infected right great toe with osteomyelitis at operation. At operation only the toe was amputated. The wound was left open and a 2 per cent sulfanilamide paste was applied to the wound. After the first application the absorption peak at sixty-two hours was 0.2 mg. per cent; after the second application there was essentially no absorption.

**CASE XI.** No. 41698. A female, thirty-eight years of age, had right nephrolithiasis following perinephritic abscess and a drainage sinus of one year's duration. Nephrectomy was performed. (During the dissection of adhesions the peritoneum was accidentally opened, but it was sutured immediately.) Eight Gm. of sulfanilamide were placed in the kidney fossa and a rubber tube inserted for drainage. Absorption peaks were, four hours, 4 mg. per cent; six and a half hours, 3.2 mg. per cent; fifty-four and a half hours, 0 mg. per cent.

**CASE XII.** No. 43799. A male, age sixty-four, had a large lipoma on the right side of the neck. The lipoma was excised, 120 gr. of sulfanilamide were applied, and primary closure performed. Blood concentration at two hours was 2 mg. per cent; six hours, 3.4 mg. per cent absorption peak; eight hours, 2.8 mg. per cent; twenty-three hours, 1.6 mg. per cent; thirty-two hours, 1.2 mg. per cent; fifty-six hours, 0.4 mg. per cent.

**CASE XIII.** No. 41244. A female, twenty-eight years of age, had a total abscess of the left breast. This abscess had existed for a period of ten days before admission. Incision and drainage were carried out. At the operation a sinus was found. Through the sinuses a watery solution of sulfanilamide was passed slowly every third to fourth day. This solution passed so slowly that crystals precipitated into the sinus tracts. The highest level obtainable was 1.4 mg. per cent; 1.4 mg. per cent and 2.0 mg. per cent. Each of these levels was obtained between twenty and twenty-four hours after installation. It had little or no influence on healing.

**Comment.** These cases are cited to show rates of absorption from various parts of the body under varying pathological condi-

tions. The last case quoted merely shows that even in such chronic edematous infectious tissue as the mammary abscess, one can produce and maintain a blood level.

**CASE XIV.** No. 43857. A male, sixteen years of age, had acute mastoiditis with subdural abscess and meningitis. At operation radical surgery was carried out with wide excision and curettage of the antrum. The wound was closed and a drain inserted; 120 gr. of sulfanilamide were applied. An absorption peak of 7.8 mg. per cent was reached in eight hours. (The patient was given ether anesthesia. He received the drug by mouth, but the peak was reached during the period of postoperative vomiting and was not maintained by oral administration.)

**Comment.** This is most interesting because of the extremely high percentage obtained. Possibly this can be explained by the extreme vascularity of the scalp. It will be noted that in the following two cases there is a marked difference in the absorption rates between the case in which there was joint injury and in which the bone marrow, as in the mastoid, was exposed.

**CASE XV.** No. 42218. A male, twenty years of age, had a dislocated left elbow with deep traumatic laceration. At operation reduction and débridement were carried out. Eight Gm. of sulfanilamide were applied and primary closure instituted. Almost primary union occurred. Absorption levels were, two hours, 1.5 mg. per cent absorption peak; 14 hours, 1.0 mg. per cent; thirty-eight hours, 0.5 mg. per cent; eighty-six hours, 0 mg. per cent.

**CASE XVI.** No. 43810. A male, twenty-seven years of age, had a compound comminuted fracture of the tibia and fibular and the distal six inches involving the ankle joint. At operation metal plates and long screws were used. (Sulfanilamide was impacted in the drill before screws were inserted. Primary closure was carried out and a plaster cast applied.) One hundred twenty gr. of sulfanilamide were used and absorption levels were four hours 6.2 mg. per cent absorption peak; six hours, 3.6 mg. per cent; twenty hours, 2.2 mg. per cent; twenty-four hours, 2.4 mg. per cent; sixty-four

hours, 5.0 mg. per cent; eighty-eight hours, 4.2 mg. per cent; one hundred hours, 0 mg. per cent. (This suggests that sternal marrow infusion may be the best route to maintain high blood levels when direct application is not obtainable, as in pneumonia, etc.)

**CASE XVII.** No. 42638. A female, sixty-one years of age, married, had inoperable carcinoma of the rectum. She had been treated by radium fourteen months prior to admission. Colostomy had been done eight months before and both ends of the colon were left open. Eight Gm. of sulfanilamide were administered orally in one dose. Absorption levels were, two hours, 6.1 mg. per cent; six hours, 9.5 mg. per cent; absorption peak; ten hours, 8.2 mg. per cent; twenty hours, 4.5 mg. per cent; thirty-nine and a half hours, 1.3 mg. per cent. Direct installation of the drug into the proximal stoma of the colostomy was carried out and the stoma was closed by pressure for six hours. Absorption levels were, two hours, 1.5 mg. per cent; four hours, 3.0 mg. per cent; absorption peak; six hours, 2.7 mg. per cent; sixty-eight hours, 2.5 mg. per cent; one hundred sixteen hours, 0 mg. per cent. The same procedure was carried out in the lower bowel. Absorption levels were, two hours, 0.1 mg. per cent; four hours, 0.5 mg. per cent; six hours, 0.5 mg. per cent; ten hours, 1.7 mg. per cent absorption peak; forty-nine hours, 0.1 mg. per cent.

**Comment.** This case is cited to show the absorption from various portions of the intestinal canal. However, it does emphasize the value of massive doses in oral administration for high blood levels.

#### REMARKS

The cases herein presented show a wide variance in absorption rate, speed and blood level percentage. In order that these remarks be made with some degree of comparability, because these experiments represent many different body locations, types of tissue where implantations were made, vascularity and lymph channels, we will in the main draw our opinions and deductions from abdominal cavity implantations.

The ability of the sulfa drugs to inhibit bacterial growth has been amply proved by John S. Loekwood,<sup>2</sup> Zaytzeff-Jern and

Meleney,<sup>3</sup> and others. All workers agree, however, that the concentration must be sufficient to overcome completely any neutralizing efforts of the bacteria. This then brings us to our first deduction. The amount of sulfanilamide used in these experiments was 8 Gm., a definitely large dose; but at no time was a blood level obtained of 8 to 10 mg. per cent as recommended by I. S. Ravdin<sup>4</sup> and others. The causes for low absorption were (1) neutralization, (2) tissue edema, (3) altered cell metabolism, and (4) altered blood and lymph supply. It is seen from the experiments that the nearer normal the peritoneum the greater the absorption; the greater the peritoneal involvement, the slower the absorption. Thus if the corollary be true, regardless of the blood level from oral or parenteral administration, the local concentration will too often be so low as to be of little value. While Marshall, Cutting and Emerson<sup>5</sup> demonstrated that sulfanilamide was distributed evenly in animal tissue (normal), Strauss, Lowell, Taylor and Finland<sup>6</sup> found the highest concentration in the red cells. If this latter finding be correct, the plasma, which actually participates in cell life, carries the smallest portion of the drug. Furthermore, by maintaining the high blood level necessary to gain tissue concentration of sufficient strength, we face the possibility of the acute hemolytic anemia reported by Wood,<sup>7</sup> Craddock,<sup>8</sup> Bennett and Ware,<sup>9</sup> or the low grade anemia seen by all of us when the drug is administered for long periods of time.

Rune Frisk<sup>10</sup> believes that acetylation takes place in the liver and spleen, hence the continuous breaking down of the drug, and since the spleen is involved, a possibility of a damage that may play a direct part in the resulting anæmia. While the same is true from absorption by direct implantation, it is slower and of lower concentration, possibly an important factor to an already toxic viscera.

Tissue reaction and adhesions have been thoroughly discussed by other authors, and

their findings of a benign action have been seen by those of us who have had the privilege of reopening an abdominal cavity.

Another phase of the subject which, to our knowledge, we have not seen recorded, is a sulfa-fast evolution, not unlike the poison fast resistance bacteria or protozoa obtain, or the radiant resistance of cancer cells. In a personal communication, Dr. J. M. T. Finney, Jr., discusses three autopsies following abdominal peritonitis: Two were the results of appendiceal disorders, the third from ruptured diverticulum. Each of these cases had direct implantation of a sulfa drug followed by oral administration. Each patient survived the initial complaint to die later from multiple abscesses. Dr. Finney makes this observation, "These three cases occur to me as examples of patients whose clinical course would seem to have been altered by something, presumably the sulfa drug, to such an extent that the true state of affairs was certainly not recognized by me." All of us have seen patients with pneumonia with a normal temperature but definite symptoms while the sulfa drug was being administered return to a typical clinical case as soon as the drug was withdrawn.

M. Mendelbaum<sup>11</sup> in his work with *Bacillus subtilis* demonstrated this resistive ability. He was able to inhibit the pedicle formation and in greater strengths the spore formation while not destroying the bacillus.

From these observations, autopsy findings, and laboratory experimentation, it can be deducted that prolonged use of the sulfa drugs permits a bacterial defense that does not necessarily destroy its pathogenicity. Therefore, the strategy of sulfa medications is single massive dosage as near the site of invasion as possible and a supportive treatment of the patient along well established lines. This is further emphasized by Zaytzeff-Jern and Meleney<sup>3</sup> when they found that the sulfa drugs either delayed or completely inhibited the development of phage resistance of certain bacteria. Prior to the advent of sulfa drugs

we depended upon phage activity. If the sulfa drugs are bacteriostatic, as so frequently proved, we are still dependent upon the phage activity; and the greater the bacteriostatic action to inhibit the development of phage resistance, the more complete will be the destruction. Later a resistance to both apparently can develop.

#### CONCLUSION

From the clinical findings it is apparent that local disorders so interfere with tissue concentration that blood levels cannot be accepted as a criterion of the local tissue concentration. From the findings of other workers it is recognized that the success of chemotherapy is dependent upon superior concentration of the sulfa drugs over the neutralizing ability of the pathogenic bacteria. Thus it becomes evident that direct application alone is the method of choice. Furthermore, from case presentation it would seem that the proper method of oral administration is early massive dosage for high level concentration (using paregoric if necessary to reduce nausea and vomiting) thus avoiding the resultant anemias of prolonged administration and sulfa-fast evolution of the invading bacteria.

#### SUMMARY

- Cases are presented to demonstrate that local disturbances, vascular impairment, and type of tissue control absorption rates of sulfanilamide as measured by the blood levels. Therefore, the nearer normal the tissue the higher the concentration.

2. Direct application of the sulfa drug to the site of pathological involvement produces the greatest bacteriostatic effect.
3. Oral administration should be in rapid massive doses and not prolonged.
4. Theoretically, it may be assumed that bacteria can become sulfa-fast and maintain their pathogenicity.

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# Case Reports

## DISAPPEARANCE OF HEMOLYTIC STAPHYLOCOCCUS AUREUS SEPTICEMIA FOLLOWING ULTRAVIOLET BLOOD IRRADIATION THERAPY\*

KNOTT TECHNIC

GEORGE MILEY, M.D.

Clinical Professor of Pharmacology, The Hahnemann Medical College and Hospital  
PHILADELPHIA, PENNSYLVANIA

THE following is a case report of a young student nurse who recovered rather dramatically from hemolytic

violet blood irradiation therapy have been published, notably by Hancock and Knott,<sup>1</sup> Hancock,<sup>2</sup> Barrett,<sup>3</sup> Miley,<sup>4-7</sup> Miley and

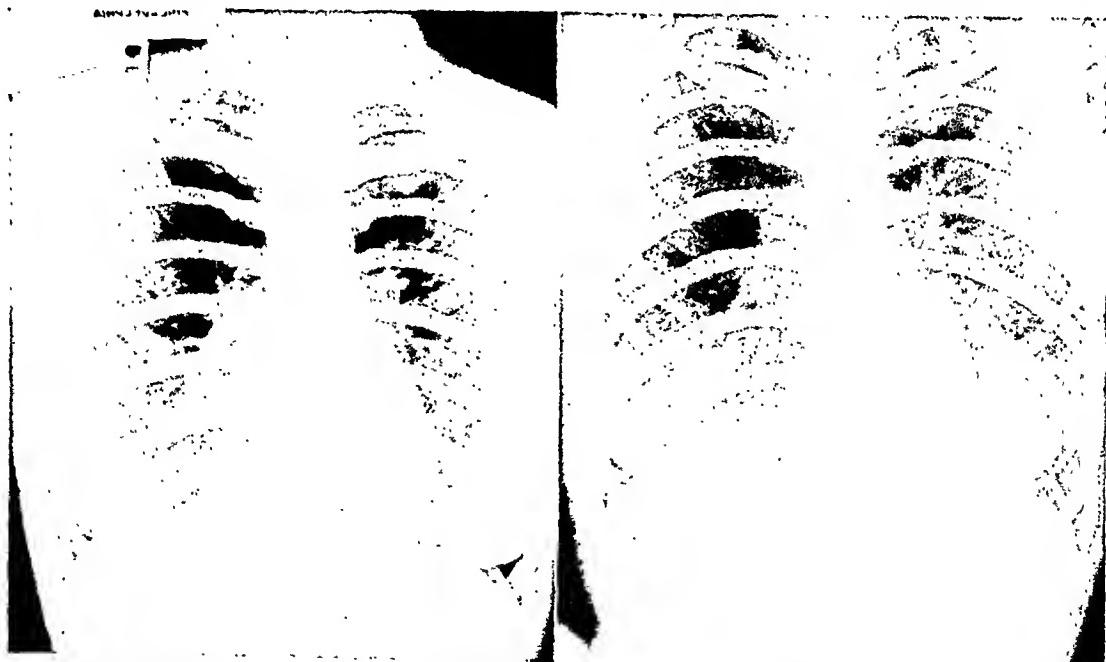


FIG. 1. Photograph of routine chest x-ray taken in October, 1942, six months previous to admission.

FIG. 2. Photograph of chest x-ray on day of admission (April 9, 1943), showing no demonstrable pulmonary disturbance although blood culture was positive at that time.

staphylococcus aureus septicemia following two applications of ultraviolet blood irradiation therapy (Knott technic).

In the last few years many accounts of the successful control of acute pyogenic infections by the Knott technic of ultra-

Rebbeck,<sup>8</sup> Rebbeck,<sup>9,10</sup> and Rebbeck and Walther.<sup>11</sup> Originally, we reported that seven individuals suffering from Staphylococcus aureus septicemia had received no benefit following the use of ultraviolet blood irradiation therapy,<sup>7</sup> however, six

\* From the Blood Irradiation Clinic, Hahnemann Medical College and Hospital, Philadelphia, Pennsylvania.

of these seven had received large amounts of sulfa drugs, and in one instance no transfusion whatsoever; furthermore all



FIG. 3. Photograph of chest x-ray taken April 12, 1943, showing triangular consolidation at the periphery of the upper right pulmonary field; this was taken the same day as the second blood culture.

were considered terminal cases when first seen. The following case report shows clearly what can be accomplished in *Staphylococcus aureus* septicemia if ultraviolet blood irradiation therapy (Knott technic) is instituted early in the course of the disease, if whole blood transfusions are used as indicated, and if no sulfa drugs whatsoever are used.

The Knott technic has been described elsewhere and consists briefly of the withdrawal and citrating of a predetermined amount of a patient's blood, plus the immediate reinjection of the citrated blood through the Knott hemoirradiator, a precision machine which automatically exposes the citrated blood safely and efficiently to a high intensity source of ultraviolet rays, and reinjects it into the venous circulation of the patient.

In the last four and one-half years the Blood Irradiation Clinic of the Hahnemann Medical College and Hospital of Philadelphia has given over 3,000 blood irradia-

tions, and has observed no deleterious effects whatsoever, a fact which has allowed a much broader clinical trial in a much greater variety of clinical entities than would have been possible had there been any significant danger factor present.

#### CASE HISTORY

On April 9, 1943, a student nurse, age twenty, was admitted to the student nurse's infirmary complaining of chills, fever, general malaise, severe cough, and severe chest pain. She gave a history of having been discharged from the local Municipal Contagious Disease Hospital on recovery from measles two days previous to admission.

Physical examination revealed an extremely toxic individual with a few vague râles in the right chest, a temperature of 104.2°F., pulse rate of 128, and her respiratory rate 28. X-ray examination revealed that both lung fields were entirely clear at this time. (Fig. 2.) Laboratory examination revealed: leukocyte count 21,400, erythrocyte count 4,580,000, hemoglobin 13.6 Gm., urinalysis negative. A tentative diagnosis of acute influenzal tracheo-bronchitis and/or pneumonitis was made at this time.

Codeine sulfate gr.  $\frac{1}{2}$  and acetyl salicylic acid gr. 10 were given immediately on admission, but the patient's condition continued to deteriorate. Eight hours after admission a blood culture was taken, and ultraviolet blood irradiation therapy was instituted.

On the following morning the patient's temperature dropped to 99.6°F., her pulse to 78 and respiratory rate to 24. The patient's leukocyte count fell to 12,200, erythrocyte count 3,920,000; however, that afternoon the patient was seized with a severe chill and her temperature rose to 105.0°F., pulse to 156 and respirations to 30. Acetyl salicylic acid gr. 3, quinine sulfate gr. 1 were given. A blood culture taken in tryptose phosphate broth showed no gross evidence of bacterial organisms at the end of twenty-four hours.

The following day, the second postirradiation day, the patient's temperature fell slightly to 100.4°F., the pulse rate to within normal limits and the respiratory rate to normal; however, in late afternoon of this day the patient was seized by another severe chill, and her temperature rose to 104.2°F., pulse

rate to 126 but her respiratory rate remained normal. A blood culture taken in tryptose phosphate on April 9th was very slightly cloudy

Then we realized for the first time that we were dealing with a severe staphylococcal septicemia, and that in all probability the



FIG. 4. Photograph of chest x-ray—anterior, posterior, and lateral views, taken April 15, 1943, showing slight resolution of triangular area of consolidation.

on gross examination at this time, after forty-eight hours incubation.

On April 12, 1943, the third postirradiation day, a second x-ray film of the chest (Fig. 3) revealed "a triangular area of pathological density in the peripheral portion of the right upper lobe where the markings suggested a beginning pneumonic consolidation." The patient's general condition had improved only slightly, if at all, during these three days, although her pulse rate had fallen perceptibly. Her leukocyte count had fallen to 6,650, erythrocyte count 3,345,000. A second blood culture was taken, and ultraviolet blood irradiation therapy was repeated; in addition a 250 cc. transfusion of whole blood was given, chiefly because the character of the pulse had changed slightly suggesting that a diminution in the circulating blood volume was occurring. Gross examination of the blood culture taken April 9th revealed definite cloudiness with beginning hemolysis. A slide made at this time showed presence of large clumps of staphylococci; subculture on Loefler's medium demonstrated clearly the characteristic golden color of the bacterial organism.

triangular area of consolidation found in the right pulmonary field on x-ray examination was very possibly a septic infarct simulating an atypical lobar pneumonia. The fact that the blood culture taken on April 9th, the day of admission, was positive at the time that the chest x-ray was negative supported this diagnosis strongly. In addition, the patient's low almost normal respiratory rate was never compatible with that of lobar pneumonia.

On the first day following the second blood irradiation the patient's temperature remained elevated between 101.4° and 104.4°F., although her pulse and respiratory rates were definitely diminished. Her general condition seemed very slightly improved.

Forty-eight hours after the second blood irradiation the patient's temperature fell to normal; her pulse and respiratory rates continued to be normal. That evening her temperature rose to 102.6°F., her pulse and respiratory rates were normal, and the patient was markedly improved for the first time. The blood culture taken two days previously, April 12th, just before the second blood irradiation was slightly cloudy. The first blood culture

taken April 9th was now completely turbid and showed extensive hemolysis.

On April 15th, three days after the second

running toward the hilus and the base of the triangle at the periphery; lateral projection showed this area to be posterior to the middle

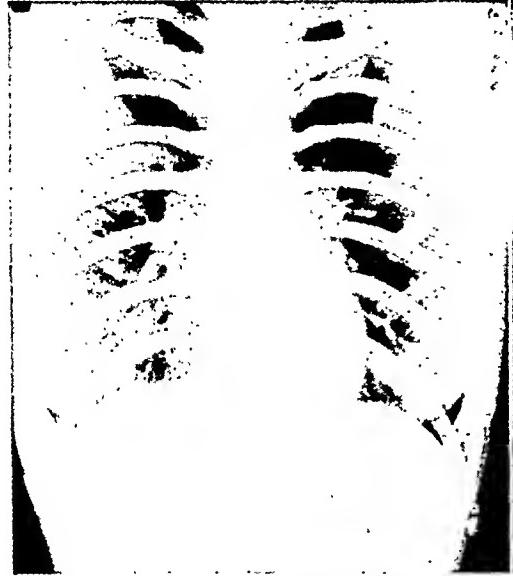


FIG. 5. Photograph of chest x-ray taken April 19, 1943, showing almost complete clearing of the pneumonic consolidation in the right upper lobe.



FIG. 6. Photograph of final chest x-ray taken April 23, 1943, shows complete clearing.

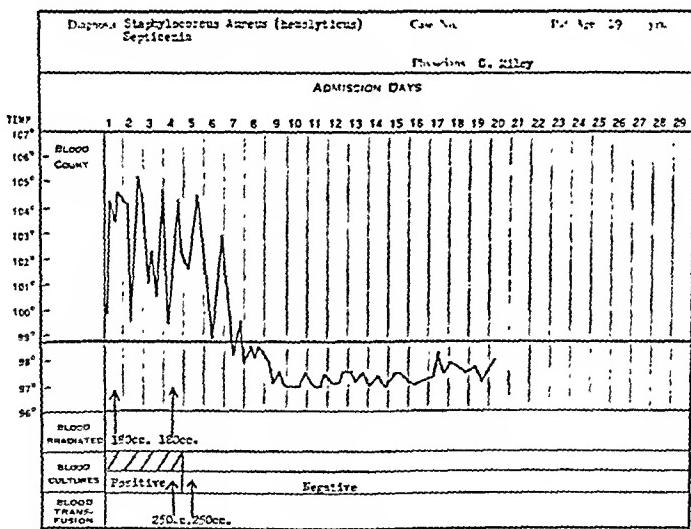


FIG. 7.

irradiation, the patient's temperature, pulse and respiratory rates were normal, and she convalesced uneventfully from this point on. X-ray examination of the pulmonary field (Fig. 4) on this day, April 15th, showed only early evidence of triangular consolidation in the lower portion, outer border of the right upper lobe, with the apex of the triangle

portion of the lung field; this consolidation had the appearance of a pneumonic process but not that of an abscess. The blood culture taken in tryptose phosphate three days previously now showed definite cloudiness but very little or no hemolysis. Microscopic examination at this time revealed the presence of staphylococci which showed much less

clumping than the original culture at the end of a similar seventy-two hour incubation period. Subculture on blood agar again revealed the presence of *Staphylococcus aureus*, and further subculture on Loeffler's medium again revealed strikingly the characteristic golden yellow of *Staphylococcus aureus*; the pigmentation was very slightly lighter in this second growth on Loeffler's than was the case of the organism isolated from the first culture.

A chest x-ray taken April 19th showed almost complete clearing of the pneumonic consolidation in the right upper lobe (Fig. 5) and a final x-ray taken April 23rd showed complete resorption of the pneumonic process involving the right upper lobe with no evidence of parenchymal inflammatory change at this time. (Fig. 6.) Subsequent blood cultures taken April 21st and 22nd were sterile. It was found that the erythrocyte count has risen to 4,000,000 and the leukocyte count had remained almost stationary at 6,400. The patient's convalescence was quite uneventful, and she left the hospital in apparent excellent condition April 28, 1943, nineteen days after admission. The patient returned to the hospital one month later, and upon physical and x-ray examination was found to be in excellent general condition.

The effects on the septic temperature in this case can be easily observed from the accompanying peak temperature graph (Fig. 7), in which the highest and the lowest temperature for each day is portrayed.

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# TRAUMATIC AVULSION OF THE SKIN OF PENIS AND SCROTUM

EDWARD S. JUDD, JR., M.D.  
Division of Surgery, Mayo Clinic

AND

FRED Z. HAVENS, M.D.  
Section on Laryngology, Oral and  
Plastic Surgery, Mayo Clinic

ROCHESTER, MINNESOTA

IT would be difficult to contemplate a more terrifying accident than the sudden loss of the skin of the penis and scrotum. Indeed, when the victim of such a mishap presents himself in the emergency ward, the equilibrium of the most experienced observer may suffer a transient disturbance. The recent admission of two such patients in close order prompted a study of the problem.

Review of the literature revealed a wide range of injuries which produce this type of avulsion. The mechanism may seem rather trivial, as evidenced by the case reported by Vernon and Kelly,<sup>5</sup> in which the patient, a sailor, was engaged in friendly scuffle on shipboard. During the activity, his adversary lifted him from the deck by grasping him by the neck and by the clothing in the pubic region. There was no great pain but the victim later noticed blood stains on his clothing. It was then discovered that the skin of the dorsum of the penis had been torn 1 inch (2.5 cm.) from the pubis and avulsion had extended toward the head of the penis. Fortunately, a long prepuce existed and it was possible to utilize this to cover the defect.

Veseen and O'Neill<sup>6</sup> reported a case in which a man was brought to the hospital in a drunken stupor, unable to recall what events had transpired. The penis was found to be denuded over the entire shaft except for one small area posterior to the glans. In addition, the integument was missing from part of the anterior surface of the scrotum. In this case, it was possible to transplant the penis into the scrotum, leaving the glans free. Dissection was carried out two weeks later. This allowed the

penis to be enveloped in a sheath of the scrotal skin and a good result was obtained.

Robertson<sup>4</sup> reported a case of extensive avulsion in which most of the characteristic features were encountered. The victim had been caught in the shaft of the motor of a launch. The skin had been torn from the penis, scrotum, perineum and pubic region. The testes hung free on the spermatic cords. Ten days after primary débridement, pockets were fashioned in the thighs and the testes were transplanted. The penis was covered by pedicle grafts originating on the two thighs. After division of the pedicles three weeks later, sloughing occurred and the grafts had to be removed. It was then necessary to apply Thiersch grafts from the thighs, which survived. Later, the testes and their compartments in the skin of the thighs were dissected free except for a pedicle at the thigh. The "cups" thus formed were rotated and sutured together to form a new scrotum, with testes and spermatic cords in place. Several minor procedures, which were performed at intervals, resulted in smooth surfaces and an independent integument for the scrotum.

Brown<sup>1</sup> supplied some very logical suggestions for the treatment of this type of injury. He has had experience especially in cases in which marked sepsis has existed.

An excellent review was made by Owens.<sup>3</sup> In addition to an exhaustive study of the literature, he pointed out many features learned through modern experience. He found that in cases in which the patients are seen immediately after the injury, grafts can be applied at once if the situation in general permits. He emphasized careful

dressing of the part after grafting and also said that pressure should be applied to the dressing. In one case, he was able to make

bine thresher and before the machinery can be stopped the clothing has engaged the pubic hair and avulsion of the skin has

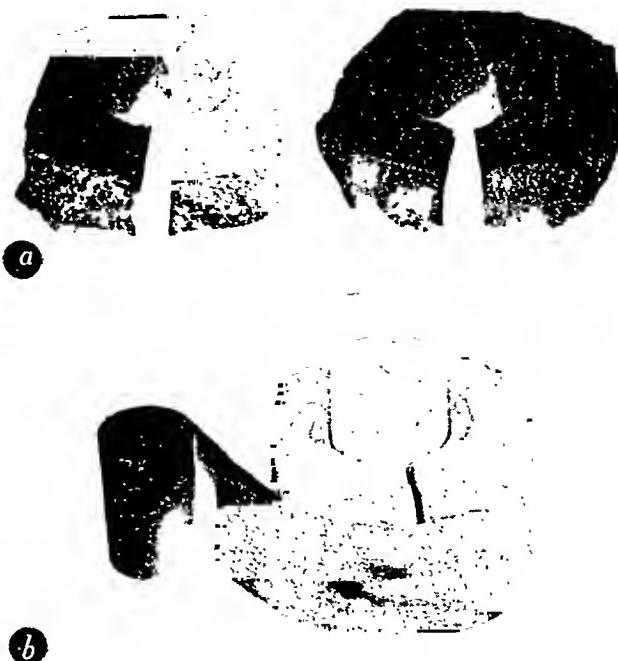


FIG. 1 *a*, sponge rubber "doughnut"; *b*, method of application of "doughnut" over skin graft applied to penis.

a tunnel in the scrotal skin and slip the penis through it; later he removed the attachments and fashioned a good sheath. In another case, in which the scrotal skin was missing, it was necessary to transplant the testes into the thigh and cover the penis with a half-thickness graft taken from the arm. Pressure was maintained by a sea sponge dressing. The patient was not interested in later dissection of the skin pockets from the thighs to form a new scrotum.

Interest in this type of injury seems timely for several reasons. The possibility of a great increase in the incidence in highly mechanized warfare is obvious. On the other hand, pointing out the possibilities of this injury in a farming community appears indicated. In two-thirds of the cases of this injury that have been observed at the Mayo Clinic the injury has been caused by farm machinery. The usual history is that the patient's overalls have become enmeshed in the gears of the com-

occurred instantly. In the two cases which have been observed most recently, a plane of cleavage appeared to have been entered and the avulsion was much neater and more uniform than any first-year medical student has ever been able to attain upon the cadaver.

Surgical restoration in these cases is now readily accomplished with modern methods of skin grafting, especially since the advantages of the Padgett dermatome have been proved decisively. The ability to take a perfectly uniform graft for this particular region is indeed appreciated. The element of pressure upon the grafted zone cannot be overemphasized. This may be obtained very satisfactorily by a "doughnut dressing" cut from sponge rubber blocks and bound snugly in place with a roll of gauze. (Fig. 1.) Postoperative care of the patients is facilitated by several modern agents. Prophylactic doses of chemotherapeutic drugs will ward off urinary infection when the use of a retention catheter is indicated.

In this regard the observation was made that the catheter may not be quite as essential as it formerly was supposed. In both of our recent cases the patients were able to do without the catheter early and the consensus was that in cases observed in the future the catheter could be removed very early. The point has been made that the tube acts as an extension mechanism for the penile shaft but the proper application of the graft and the dressings may make this element superfluous. Therapeutic doses of chemotherapeutic drugs were instrumental in overcoming sepsis of the traumatized tissue, which is very liable to be associated with this type of injury. If the patient is not seen immediately, it is well to employ sulfonamides in the preparatory period. A solution may be applied locally or may be administered orally or parenterally as indicated.

Priapism is a source of considerable distress to the patient, especially nocturnally. Whereas a certain degree of physiologic alteration in tone and size is beneficial to the graft after the immediate postoperative period, early in the course it may present an actual complication. We have administered stilbestrol in such cases, with a moderate degree of success.

#### CASE REPORTS

The following nine cases have been observed at the clinic. In every case, tetanus antitoxin was administered, and in cases in which it seemed indicated, gas gangrene antitoxin also was employed.

**CASE 1.\*** An eighteen-year old boy was admitted to the hospital twelve hours after an accident. His trousers had been caught in a pulley shaft and had been torn off completely. A large portion of the skin had been torn from the scrotum and all of the skin had been torn off the penis. He had voided once but since that time there had been complete retention. It was necessary to catheterize the patient. Tannic acid dressings were applied to the injured regions. Twenty-four days later,

Thierseh grafts from the right thigh were implanted on the granulated regions. Petro-latum dressings were applied with as much pressure as possible. When he was dismissed from the hospital twenty-five days after the operation, it was noted that the grafts had "taken very nicely."

**CASE II.** A forty-eight year old man was brought to the hospital three hours after his trousers had been caught in a corn husking machine. Examination revealed avulsion of the skin of the dorsum of the penis, extending from a point over the pubis to the corona. Operation was undertaken immediately; fortunately, a long prepuce existed and it was possible to free the skin and retract it proximally. The edge was sutured at the base and a satisfactory covering was obtained. Healing was prompt but moderate deformity persisted. Marked edema of the prepuce was troublesome for a time but gradually subsided.

**CASE III.** A thirty-one year old South American came to the clinic three months after an accident. His trousers had been caught in a drive shaft at a saw mill. The penis and scrotum had been torn and the left testis had been pulled off. The wound had been sutured immediately and several plastic operations, including a penile graft and an attempt to close a urethral fistula, had been performed.

At the clinic it was noted that, in addition to absence of the left testis, the skin was missing from the ventral aspect of the shaft of the penis. Contracture of scar tissue had produced marked deformity on the left side. The graft had not taken and a urethral fistula persisted. He was hospitalized for thirteen days, during which time wet dressings were employed and an indwelling catheter was inserted after the normal meatus was located. At the end of this time, the excess of granulation tissue and contracted scar were removed. The free surfaces were covered with a shaved graft from the right arm. Pressure was maintained by leaving the sutures long and tying them over a tight gauze roll. Three weeks later, the remnant of scar was dissected from the base of the shaft of the penis. After the deep fibrotic tissue had been freed, the penis could be moved into a more nearly normal position. A graft from the inner aspect of the right arm was used to cover the raw surface. When the patient was dismissed it was noted that the grafts had taken very well. The plan was to have him return

\* This case has been reported previously by Counsellor, V. S. and Palmer, B. M.

for final grafting of the one remaining region and for closure of the urethral fistula; however, it has been impossible for him to undertake the trip back from South America because of war conditions.

**CASE IV.** A fifty-eight year old sailor stated that thirty-five years previously his right foot had been caught in a running rope. He had been dragged along the deck and had been struck on the perineum and buttocks as well as on the lower part of the abdomen. The skin had been stripped from the perineum, from the base of the penis and from the scrotum. The wounds had been sutured immediately. Upon his return to land, numerous unsuccessful attempts had been made to repair the injured penis, including an attempt at a pedicle transfer of tissue from a living dog. It had been necessary, also, to amputate his right foot. He came to the clinic because of his desire to have the deformity of the penis corrected. Examination revealed that the penis was almost completely buried in dense scar tissue in the scrotum. The right testis was markedly atrophic.

At operation, the atrophic right testis was removed in order to permit use of the scrotal tissue on this side for the plastic repair. The fibrotic tissue binding the penis into the scrotum was then dissected, and the skin on the right side of the scrotum was used to fashion a flap to cover the ventral surface of the proximal penile shaft. A graft taken from the left thigh was applied to the remaining raw surface of the penis. A retention catheter was inserted. Sulfathiazole was administered as a prophylactic against urinary infection. The patient left the hospital in fifteen days, at which time it was noted that 98 per cent of the graft had taken. Two years later, through a report from his physician, it was learned that the patient was well pleased with the result and had married.

**CASE V.** An eighteen year old boy had been caught in a combine harvester one month before he came to the clinic. The skin had been torn from the entire penis except at the distal 2 em. Almost all the skin had been stripped from the scrotum and a small portion of the perineum beneath the base of the penis had been denuded. The testes had not been injured. He had been in a hospital for one month and treatment had been directed toward clearing up the infection which had resulted. When he was examined at the clinic very healthy

granulation tissue was present throughout the injured region.

After a short period of hospitalization, during which mild antiseptics were employed, operation was performed. The excess of granulation tissue was trimmed away from the region about the right testis, shaft of the penis and the perineum. A flap obtained from the right thigh was turned up and utilized to cover the perineum and the area just beneath the base of the shaft of the penis. By employing the dermatome, grafts were then obtained from both sides of the abdomen and placed over the right testis and shaft of the penis. Flat gauze was applied directly to the graft and sponge rubber was fitted over this. The edges of the rubber were sewn around the penis in "doughnut" fashion and a binder was wound about this for pressure. A retention catheter was then inserted. At the first change of dressing one week later, it was noted that the perineal graft had taken perfectly, as had the one on the ventral aspect of the shaft of the penis. On the dorsum of the shaft and over the pubic region the condition of the grafts was poor but the prospect for subsequent epithelialization appeared good. Sixteen days later, radium was applied because of the exuberant granulations and a tendency to keloid formation. When he was dismissed, a very good result was reported.

**CASE VI.** A boy, aged nine years, was brought to the hospital nine hours after his overalls had been caught in the pulley of a tractor. The scrotum had been almost denuded, the left testis had been bruised badly, and the skin had been torn from the shaft of the penis except at the tip of the prepuce. In addition, the left thigh had been lacerated badly. Immediate treatment on admission consisted of application of wet dressings and petrolatum gauze. Six days later, the lateral borders of the scrotum were freed as far as possible and the flaps thus raised were brought together over the exposed testis. Five Thiersch grafts from the right thigh were attached to the penis. These were sutured together wherever possible and were also attached to the margins of the normal skin. At several points, it was possible to suture the grafts to the mucous membrane. A dressing of petrolatum gauze was applied. When the patient was dismissed sixteen days later, all of the wounds except a broad laceration of the thigh had healed and

grafts had taken well. One month later, the appearance of the penis was very natural.

**CASE VII.** A farmer, aged sixty-one years, had been injured in a binding machine a short time before he was brought to the hospital. Most of the skin had been torn from the scrotum and penis. The left testis had been lacerated severely and profuse hemorrhage had occurred from a varicocle which had been present for many years. He immediately was taken to the operating room where left orchidectomy was performed. This left enough redundant scrotal skin to cover the right testis completely. The short rim of skin remaining about the glans was brought backward and sutured to the cut edge of scrotum and to the torn margin of the skin above the symphysis pubis. Seventeen days later, a plastic operation was performed to liberate the penile skin from the region above the symphysis pubis. One week after this, multiple pinch grafts from the left thigh were applied to the base of this region. The dressing applied was a gutta percha sheet covered with saline sponges. Dakin's tubes were incorporated and a sea sponge was applied to produce pressure. Examination eleven days later revealed that about 40 per cent of this graft had taken. When this patient was dismissed the result was fairly satisfactory except for a certain amount of persistent granulation tissue.

**CASE VIII.** A farmer, aged fifty-four years, had been caught in the grain elevating mechanism of a combine thresher. His left arm had been drawn in first, then his left foot and lower leg, and finally his scrotum. The left external malleolus and the left humerus had been fractured. The skin had been torn away from an area extending from a point above the symphysis pubis to the lower sixth of the penis and including the anterior portion of the scrotum. A flap of skin had been left dangling between his thighs. The fractures had been reduced and casts had been applied. The flap of skin had been returned as nearly as possible to its original position, where it had been sutured. A thick layer of sulfanilamide had been applied to the injured region and a retention catheter had been inserted.

On the fifth day after the patient had been injured, he was brought to the hospital. At this time, the scrotum was necrotic. The wound over the symphysis was rather dirty, as was a deep laceration in the perineum, which ex-

tended close to, but not quite into, the rectum. The skin of the penis was entirely absent except for a small rim at the corona. Immediate treatment consisted of the application of gauze moistened with hydrogen peroxide, and administration of tetanus antitoxin and gas gangrene antitoxin. It was suggested that the application of roentgen therapy over the scrotal area might help ward off gas gangrene but this was not considered particularly advisable as the testes were deemed to be entirely viable. A blood transfusion was given.

When a sharp line of delineation was evident, thorough débridement was performed. This required removal of the skin of the entire anterior half of the scrotum and of many tags on the penis. There were scattered abscesses in the pubic region and one large abscess in the perineum. Bits of overall cloth and clumps of sulfanilamide powder came away with the necrotic tissue. Irrigations of hydrogen peroxide were employed but no dressing was applied. A light cradle was maintained on the bed at all times to allow free access of air and the lights were turned on periodically. In the next eighteen days the fracture of the humerus was reduced by an open operation. Sulfathiazole was administered in carefully controlled doses. At the end of this time, a graft was taken from the anterior aspect of the right thigh with the dermatome. This was transferred to the anterior aspect of the scrotum and a planned segment of it was then sutured snugly about the penis. The edges were sutured to the remnant of skin at the corona and at the pubic symphysis. The usual slits were made to permit egress of serum. A flat gauze dressing was tied in place over the shaft of the penis by utilizing the ends of the sutures, which had been left long. An attempt was made to maintain pressure by using a sea sponge but difficulty was experienced in maintaining the desired pressure. The retention catheter was left in place.

The dressing was not disturbed for ten days. At this time, it was found that at least 75 per cent of the graft on the scrotum had taken. However, there was less growth on the penile shaft, apparently because the pressure had not been constant and uniform. There also was a slight infection at the margins. Irrigations of sulfanilamide were then employed. The patient underwent several changes of casts and manipulations of the extremities and was then allowed to get out of bed. The catheter was removed

and micturition occurred spontaneously. There was no urinary infection of moment. Two months after he had been admitted to the

regions had been lacerated and that the external oblique fascia had been lost in places. Bits of hair, clothing and dirt had been ground



FIG. 2. Appearance of patient in Case IX at time of dismissal from hospital. The wounds in the groins have healed; testes are visible in thighs; suture lines are discernible on skin graft on penis. Original merthiolate stains are visible on skin of abdomen and thighs.

hospital, the scrotum appeared entirely normal. There were many areas of healthy epithelium over the shaft of the penis but there were still a few islands of granulation tissue. The original skin at the corona was still quite edematous. The patient had no symptoms and returned to his home. Two months later, he returned to the clinic. Scar tissue was dissected from the ventral aspect of the shaft, which was covered with a skin graft taken from the thoracic wall. A sponge rubber "doughnut" dressing was bound in place. This graft took well and the patient was well satisfied with the result.

**CASE IX.** A farmer, aged thirty-two years, was brought to the hospital two hours after his overalls had been caught in the gears of a combine thresher. The trousers had been twisted off and had engaged the pubic hair and torn the skin from both groins, the entire penis, the suprapubic region and the entire scrotum. In spite of this catastrophe, he had been able to get up and walk to the car. At the hospital, it was seen that the inguinal

in the wounds. The denuded penis appeared quite healthy but there was a thin, shaggy film of very dark tissue over the testes. The spermatic cords had been partially exposed. We considered the immediate application of grafts to the shaft but in view of the degree of contamination of the adjacent tissue it was decided to allow a preliminary period for cleansing; therefore, the edges were débrided thoroughly. After careful, gentle cleansing with soap and water, the edges of the wounds in the groins were approximated with widely spaced sutures. A retention catheter was inserted. Loose gauze was wrapped about the shaft and the testes and was kept moist with hydrogen peroxide and gauze moistened with sulfanilamide. Sulfathiazole was administered by mouth.

Four days later, the patient was taken to surgery. The wounds of the groins appeared to be healing very satisfactorily. The penile shaft was covered by clean granulation tissue throughout; however, the thin tissue over the testes was entirely necrotic. All the dark tissue

was removed and the spermatic cords and testes were left completely exposed. Pockets were fashioned in each thigh, in the loose tissue just anterior to the great saphenous veins. Each testis and spermatic cord was dusted with sulfathiazole and then slipped into the corresponding thigh pocket. The wound on each side was closed with several interrupted sutures. A small abscess, which was situated in the lower part of the left perineal region, was drained.

In the interval, the catheter was removed and micturition occurred spontaneously. Gauze soaked in a solution of sulfanilamide was applied to the shaft of the penis and to the wounds in the groins. Periodic exposure to the light cradle prevented maceration. Two weeks after the first procedure, one of us (F. H.) took a graft from the wall of the left side of the thorax by using the dermatome. This was sutured to the shaft of the penis and covered with a flat gauze surrounded by a heavy "doughnut" cut from large sponge rubber blocks. This was held firmly in place by a roller bandage. A small triangular region beneath the base of the penis was covered with a separate part of the graft but it was difficult to obtain proper pressure at this point. A retention catheter was again inserted. The dressing was not disturbed for ten days. At the end of that time, it was found that

90 per cent of the graft had taken. At the base of the penis, in the difficult triangular region, the graft had not taken but the granulation tissue appeared healthy. Petrolatum gauze was applied to the penis. The catheter was removed and plain dry dressings were applied to the wounds in the groins. At the end of thirty-two days, the patient was dismissed with perfectly healed wounds and a very nearly normal appearing penis. (Fig. 2.) He was so gratified with the result that he had little interest then in an attempt to free the pockets in the thighs and fashion a new scrotum. He has returned for several examinations. The result is excellent and he is able to do all his farm work without difficulty.

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# COMMON DUCT STONES CAUSING JAUNDICE\*

CHOLECYSTITIS, HEPATIC DUCT STONES, DUODENAL ULCER AND  
DUODENAL FISTULA AS COMPLICATIONS

WILLIAM T. LEMMON, M.D., MAJOR GEORGE W. PASCHAL, JR., M.C., A.U.S.  
MAJOR WILLIAM BRODY, M.C., A.U.S. AND HENRY G. HAGER, JR., M.D.,  
PHILADELPHIA, PENNSYLVANIA

THE case to be presented is of great interest, not because it represents any new clinical entity, nor does it present any new form of treatment, but its interest is dependent upon the fact that in a relatively short period of time the patient presented so many surgical problems of a major nature which required repeated heroic surgical procedures.

## CASE REPORT

The patient, a white American male, age sixty-five, was admitted to the Women's Medical College Hospital on July 24, 1941, complaining of severe pain in the right upper quadrant, with nausea and vomiting. The present attack began following the ingestion of a milk shake containing eggs. The pain was so severe that an injection of morphine sulfate was needed. The vomitus consisted of food recently eaten and did not contain either bile or blood. He had had several attacks of a similar nature during the previous five months. He had not been jaundiced following any of the other attacks, but had noticed that his urine was rather yellowish after each attack.

His past history revealed an operation for gallbladder disease in 1924. At that time he had had several attacks of right upper abdominal pain, followed by jaundice. At operation an enlarged, thickened gallbladder was found, which contained very thick bile. There was no enlargement of the liver or extrahepatic bile ducts. An indurated area was found on the posterior wall of the duodenum which proved to be an ulcer. The gallbladder was opened, sutured to the anterior wall and drained. Following the operation, the patient was fairly well until five years before, when he began to have symptoms of a duodenal ulcer. He had several attacks of bleeding from the ulcer, but for the past two years he had been symptom

free, but he had been on an ulcer diet and had been receiving medical treatment.

Physical examination on admission revealed a fair degree of jaundice, noticed in the sclerae, the buccal mucous membranes and the skin. There was marked tenderness in the upper right quadrant with associated muscle guarding. There was a scar of the previous operation in the right upper quadrant. Otherwise, the physical examination was negative. His weight was 180 pounds. The urine examination was negative except for an excessive amount of bile. The blood count was normal and the icteric index was 15. Blood urea nitrogen was 15.5 mg. per cent and the blood sugar was 70 mg. per cent.

The patient was put to bed and improved under treatment, the jaundice gradually clearing. On July 28th, a cholecystogram was done, which showed a large gallbladder which failed to concentrate the dye very well. Following a fat rich meal the gallbladder emptied very poorly. No evidence of stones was found nor were they found in a previously done flat plate. An x-ray diagnosis of chronic cholecystitis was made. Following this a biliary drainage was done which revealed a few cholesterol crystals. The patient steadily improved, until on the tenth day following admission, he had another attack of severe right upper quadrant pain which was relieved by morphine sulfate. The pain had no particular radiation but involved the whole upper abdomen. It was accompanied by nausea and vomiting and marked upper abdominal rigidity, more marked on the right side. It was decided that the patient was to be operated upon, and he was given vitamin K hypodermically, and intravenous glucose for several days prior to operation.

The operation was done August 7, 1941, using intratracheal cyclopropane anesthesia, given by Dr. Frederick P. Haugen. The abdomen was opened through the region of the

\* Presented before the Philadelphia Academy of Surgery, March 1, 1943.

old scar, and many dense adhesions were found involving the anterior abdominal wall. The gallbladder was adherent to the anterior abdominal wall, and adhesions bound the gall-

closed by layers. The duration of the operation was one hour and twenty-six minutes. The patient left the operating room in good condition.

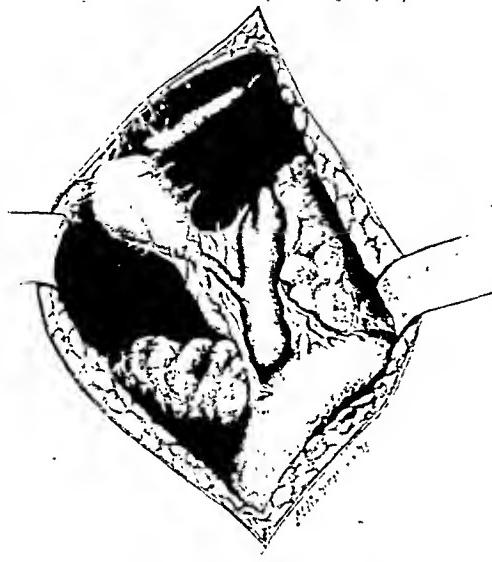


FIG. 1. Condition found at first operation: large thickened gallbladder with many dense adhesions; large dilated ducts from which only biliary sand and mud was obtained at the first operation.

bladder to the duodenum and the right flexure of the colon. (Fig. 1.) The adhesions were freed and the gallbladder mobilized. The cystic duct was dissected out, ligated and cut. The cystic artery was ligated and cut. The gallbladder was then dissected from its bed. The common bile duct and the common hepatic duct were found to be greatly dilated. An ulcer was found which involved the posterior wall of the first part of the duodenum, extending well onto the anterior wall. The head of the pancreas was enlarged and moderately firm. The colon was normal. The common bile duct was aspirated and dark thick bile was obtained. It was then incised and explored with a lead probe. A large amount of so-called "biliary mud and sand" was obtained, but no stones were found in the common duct. The probe was passed down into the duodenum and removed. A soft rubber catheter was inserted through the common duct into the duodenum and irrigated with sterile water which distended the duodenum. A T-tube was then inserted into the common duct, and the incision in the duct was closed around the tube. A Penrose drain was placed in the subhepatic fossa and the abdomen was



FIG. 2. Cholangiogram made following first operation showing two stones causing complete block of the common bile duct. These stones probably slipped down from the greatly dilated hepatic duct (s) following the first operation.

The course following the operation was rather smooth. A large amount of bile drained by way of the T-tube and Penrose drain. On August 13th, it was noted that the stools were definitely clay-colored. On August 15th, the patient was x-rayed, following the instillation of lipiodol into the T-tube. The cholangiogram revealed a marked dilatation of both the hepatic and common bile ducts, with two negative shadows in the common duct, one at the end of the common duct, and one a short distance above it. These were interpreted to be gallstones.

During this period, the patient seemed to be depressed; he had no appetite and was discouraged. The stools remained clay-colored. There was a large amount of bile draining from the T-tube and the incision.

On August 19th, the T-tube was irrigated with normal saline, followed by the instillation of a mixture of 5 cc. of ether and  $2\frac{1}{2}$  cc. of

alcohol. This produced rather severe pain, and after the pain had subsided, the tube was aspirated but nothing was obtained. Then the tube was clamped for a period of two hours,

removed and the duct opened and explored. An incision of about 4 cm. in length was made into the head of the pancreas in order to expose the lower end of the common duct.

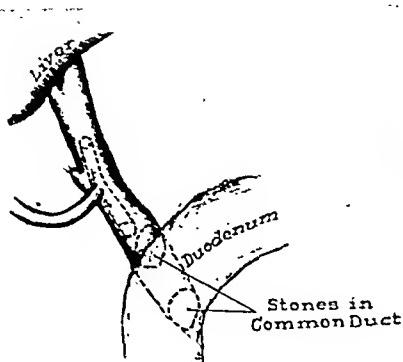


FIG. 3. Condition found at second operation. The T tube in place in the common duct with the two stones in the common duct causing complete obstruction. The duodenal ulcer is also shown.

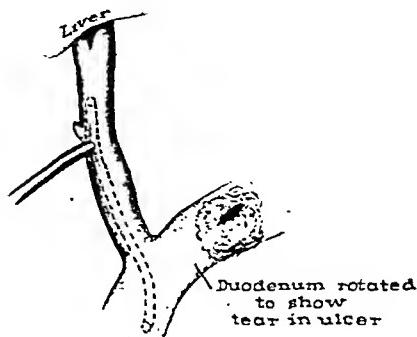


FIG. 4. Findings at the third operation. The duodenal ulcer had a large opening in it which had the appearance of a traumatic rupture. The T tube is shown with the lower limb extending into the lumen of the duodenum.

and the patient complained of pain, which was relieved when the flow of bile was again resumed from the T-tube. On the following day, the tube was again irrigated and a mixture of 20 cc. of ether and 10 cc. of alcohol was instilled into the tube. This again caused severe pain. The same procedure was repeated on the following day. On every occasion when the tube was clamped for an appreciable period of time, the patient complained of pain, which was relieved by releasing the clamp on the tube. During this time, the stools were alcoholic.

On August 22nd, another cholangiogram was done which showed a complete common duct obstruction due to a stone in the lower end of the duct with another just above it. (Fig. 2.)

On the following day, the patient was given 700 cc. of bile which had been collected from the T-tube, along with three 2 mg. doses of vitamin K, hypodermically, and intravenous glucose solution. The next day, he received the same treatment, with the addition of a transfusion of 400 cc. of citrated blood.

On August 25th, the patient was operated upon, using intratracheal cyclopropane anesthesia, given by Dr. Haugen. The abdomen was entered through the old incision and after separating many recently formed adhesions, the common duct was exposed. The T-tube was

The duct was then further incised, and the stones which had been visualized in the cholangiogram were found and removed. This approach was chosen because it was feared that opening the duodenum in the presence of the large indurated ulcer might result in a duodenal fistula. A T-tube was introduced into the common duct, the lower arm of the tube being long enough to allow it to pass into the lumen of the duodenum. The duct was closed about the T-tube, a Penrose drain placed in the subhepatic fossa and the abdomen was closed in layers. The duration of this operation was two hours and forty minutes. The patient left the operating room in fair condition. (Fig. 3.)

Following the operation, the patient did very well, but it was noted on the second day following that there was a large amount of watery discharge on the dressings. When the patient took a drink of water, it would appear on the dressings almost immediately. On August 28th, methylene blue (2 gr.) was given by mouth and it soon appeared on the dressings. It was then clear that there was a leak in the duodenum, thought to be due to a perforation of the old ulcer, possibly traumatic in origin.

There was no abnormal pain or distress accompanying this development. It was de-

cided that the patient should be re-opened, and on August 29th, he was given a 500 cc. transfusion of citrated blood.

The operation was done on August 30th,

drain was placed in the same area and the abdomen was closed. (Fig. 5.) During the operation, the patient received a continuous infusion of normal saline, which was inter-

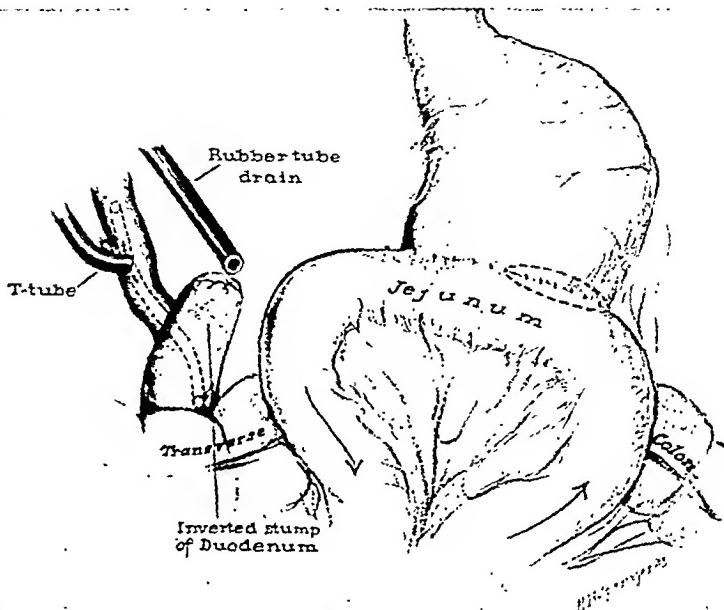


FIG. 5. After the third operation the T tube has the lower limb into the lumen of the duodenum. Subtotal gastrectomy has been done and the soft rubber drainage tube for aspiration placed at the inverted duodenum.

with intratracheal cyclopropane anesthesia given by Dr. Haugen. The abdomen was entered through the same incision. Adhesions were divided, and the duodenum exposed. The ulcer was found to have a large opening in it which appeared to be more of a tear than a perforation. It was on the posterior aspect of the duodenum, the opening being roughly 1 cm. long and  $\frac{1}{2}$  cm. wide. (Fig. 4.) The duodenum was mobilized, clamped distal to the ulcer and divided. The stump of duodenum was inverted with a layer of interrupted chromic catgut sutures, and the closure was re-inforced with layers of interrupted black silk sutures. The blood supply to the distal two-thirds of the stomach was ligated and divided, along with the peritoneal reflections. Then the stomach was divided between clamps, and the superior half of the open end of the stomach was closed with a continuous suture of chromic catgut. A loop of jejunum was brought up and an antecolic gastrojejunostomy was done according to the Hofmeister technic. After securely re-inforcing the anastomosis at the angles, a rubber tube was placed near the inverted stump of the duodenum; a Penrose

ruptured to allow the infusion of 650 cc. of citrated blood. The duration of this operation was two hours and forty minutes.

Following this operation, the patient had a very stormy time for about five days, then began a period of apathy, anorexia and worry. The rubber tube that had been placed near the duodenal stump, had been placed there in anticipation of a leakage. It had been connected to a small electric suction pump, and any fluids in the vicinity of the end of the tube were continuously aspirated and collected. This kept the wound dry and in good condition. (Fig. 6.) He was given a daily transfusion of 250 cc. of citrated blood for nine days following the operation. Wound leakage did develop as anticipated, and the bile and pancreatic juices were collected by means of the suction pump. They were re-introduced into the patient by means of a stomach tube. The T-tube was removed on September 12th, because it no longer functioned, being plugged with thick bile.

There was a large amount of bile-stained fluid obtained by the method of continuous aspiration. This then appeared to be healthy

bile, and most of it was fed back to the patient. By September 23rd, the patient seemed to be gaining; his appetite had picked up, and the amount of drainage was less.

weight. He is enjoying excellent health. He had some drainage from his abdominal wall occasionally until November, 1942. Since that time, there has been no discharge.

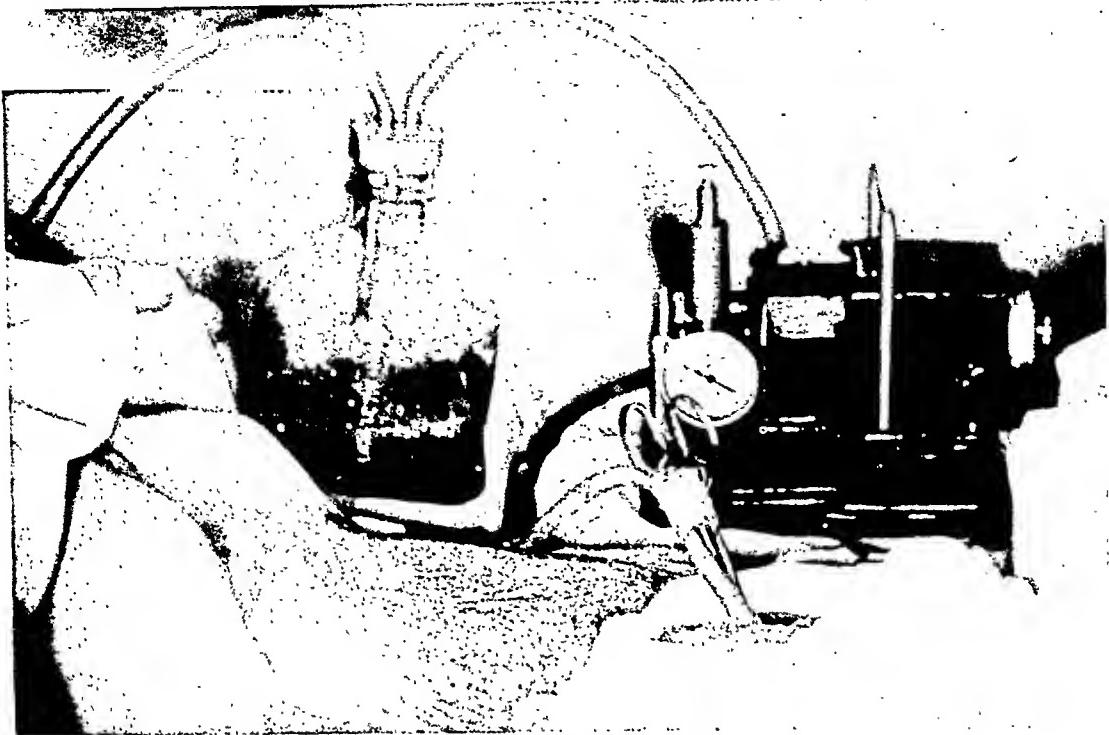


FIG. 6. Continuous suction apparatus used.

From that time, the patient improved steadily, and with the improvement a gradual diminution in the amount of drainage was noted. On October 13th, the patient was allowed out of bed. He then weighed 125 pounds. After the patient was ambulatory, his general physical condition improved rapidly, with a marked decrease in quantity of drainage. The patient was discharged from the hospital on November 16, 1941. At that time there was a fair amount of drainage from the wound, but it was believed that he would make more rapid progress if allowed to leave the hospital.

The success of this recovery is due in no small part to the excellent and untiring treatment from the medical angle by Dr. William Brody. The patient's nutrition was kept up by the administration of his own bile and pancreatic juices, supplemented by ox-bile and pancreatin, nearly all of the vitamins, and special foods. A close study of the treatment sheet reveals a profound study of nutrition.

Following his discharge from the hospital, the patient improved steadily, and at this writing weighs 165 pounds, which is his ideal

#### SUMMARY

A case has been presented in which the patient suffered with (1) common duct obstruction due to stones, (2) chronic cholecystitis, (3) duodenal ulcer, (4) perforation of the duodenal ulcer, and (5) duodenal fistula.

This patient was treated surgically, with three separate operations, the actual operative time of which totaled six hours and forty-six minutes. These operations were done within a period of twenty-three days. In our opinion, the result obtained could not have been accomplished with less surgery, which consisted of: (1) cholecystectomy with exploration and drainage of the common duct, (2) removal of stones from the common duct, and (3) subtotal gastrectomy for ulcer which had perforated.

A simple method of continuous suction was used, which materially assisted in healing of the wound by keeping the wound free of irritating discharge.

# DIFFUSE POLYPOSIS OF THE LARGE INTESTINE

CHARLES W. McLAUGHLIN, JR., M.D.

Assistant Professor of Surgery, University of Nebraska College of Medicine

OMAHA, NEBRASKA

**D**IFFUSE polypoid disease or polyposis of the colon has been recognized as a pathological entity since 1863 when originally described by Virchow.<sup>41</sup> Hullsieck,<sup>16</sup> in 1928, found 127 reported cases and more recently Scarborough<sup>36</sup> was able to collect a total of 301 cases recorded prior to 1937. A review of the literature reveals an additional group of thirty cases reported from 1937 to 1942 bringing the total number of collected cases to 331.

Allingham<sup>1</sup> did not observe a single instance of diffuse colonic polyposis in 4,000 consecutive examinations in St. Marks' Hospital, London. Martin<sup>25</sup> reported five cases with diffuse polyposis of the colon in 1,500 sigmoidoscopic examinations and Buie<sup>6</sup> found fifty-five cases of diffuse polyposis in a series of 1,234 patients with polyps of the colon. Mayo and Wakefield<sup>26</sup> note that 4 per cent of patients examined in the Proctological Section of the Mayo Clinic had one or more polyps but only .04 per cent of this latter group had disseminated polyposis.

*Classification.* The classification of polyposis of the colon suggested by Erdman and Morris<sup>10</sup> is generally accepted today. All cases are divided into two major types: (1) Adult or acquired type, usually occurring in middle or late adult life, and characterized by a prolonged history of colitis. Unmistakable evidence of inflammation in the colon is always present and the polyps tend to be less frequent than in the other type. (2) Adolescent (congenital disseminated) type occurring in individuals in youth or young adult life. A history of a similar condition can usually be obtained in other members of the family. The symptoms are those of recurrent bouts of abdominal pain associated with cramps

and bloody diarrhea. Pathologically, the colon is usually diffusely studded with polyps from the cecum to anus.

Ample clinical study has demonstrated that chronic ulcerative colitis frequently results in the development of diffuse polyposis of the colon.<sup>3,17,21,37,42</sup> Kahler<sup>20</sup> reports that polyposis develops in 10 per cent of patients suffering with chronic ulcerative colitis and Rankin<sup>31</sup> found that diffuse polyposis was present in sixty-nine of 693 cases of proved chronic ulcerative colitis. Bargen<sup>3</sup> considers the relationship of the acquired to the congenital type of adenomatosis of the colon to be approximately 4:1.

Cripps,<sup>23</sup> in 1882, first pointed out that a definite hereditary factor was present in certain cases of polyposis of the colon. The heredofamilial character was subsequently emphasized by Lockhart-Mummery<sup>23</sup> and has been confirmed by many observers.<sup>2,3,11,16,27,28,29,33,35</sup>

It has been demonstrated that polypi are not present in susceptible individuals at birth but tend to make their appearance in childhood or about the age of puberty. This factor results in much difficulty in classification and necessitates both a careful history and examination of other members of the family to establish a diagnosis of heredofamilial polyposis.

Regardless of the familial or acquired basis on which diffuse colonic polyposis develops, the incidence of carcinoma is unusually high. Scarborough<sup>36</sup> states that "probably no benign process has a higher incidence of malignant degeneration than colonic polyposis." In his collected series the incidence of carcinoma was found to be above 50 per cent. Hullsieck<sup>16</sup> reports that 34.6 per cent of his collected series presented evidence of malignant degener-

ation. One may consider that practically 100 per cent of patients with diffuse polyposis of the colon will develop carcinoma of the large bowel or rectum if they survive for a sufficient number of years. Those individuals with the familial form of the disease tend to develop malignant degeneration early in life, occasionally during the second decade and with great frequency during the third and fourth decades.

The other common complications encountered are anemia and wasting incident to the prolonged diarrhea with blood loss. Obstruction incident to enlargement of the polypi with or without intussusception is also reported.

**Diagnosis.** This is occasionally facilitated by the presence of a definite family history. However, in many cases in which the pathological picture is typical of the adolescent or familial type, no family history can be obtained. The usual symptoms are those of intermittent attacks of crampy abdominal pain associated with diarrhea, blood in the stools, weakness and anemia. Frequently one can obtain a history of the passage of polyps by rectum. Diagnosis is made by digital examination if the lower rectum is involved, by sigmoidoscopic examination and barium enema. Examination of the colon using injected air as a contrast medium is a very useful adjunct in visualizing the mucosal pattern.

**Treatment.** The treatment of diffuse polyposis of the large intestine may be considered under three headings: (1) Medical or conservative, (2) roentgen therapy, and (3) surgical.

Ample clinical evidence is available to demonstrate that medical or conservative therapy is entirely unsatisfactory except as a palliative measure. It should be employed only to prepare patients for more radical surgical measures or for those who refuse such treatment. Medical therapy is primarily directed toward improving the general health of the individual, correcting the anemia, and controlling the frequent bouts of diarrhea with increased

blood loss. Its ineffectiveness results from the natural tendency of the disease process to advance with the ultimate development of malignant degeneration in one or more areas of the colon or rectum.

Roentgen therapy has been used in the treatment of diffuse colonic polyposis by several observers during the last ten years.<sup>4,7,27,28,36,40</sup> Very heavy doses of abdominal roentgen therapy have been employed with severe systemic reactions. Vanzant<sup>40</sup> considers that the benefit from this form of treatment results from a destruction of lymph tissue in the mucosa of the colon, being frequently followed by the passage of numerous polyps per rectum. Barker,<sup>4</sup> Chandler,<sup>7</sup> McKinney<sup>28</sup> and Vanzant<sup>40</sup> all noted subjective improvement in their patients following treatment, with a reduction in the number of polyps as demonstrable by barium enema studies. However, the majority of the recorded patients treated by radiation therapy subsequently died with carcinoma of the colon or rectum, no five-year cures being reported in the literature to date. One must conclude from available evidence that roentgen therapy may temporarily relieve the symptoms and delay the progress of the disease but fails to effect a resolution of the polyposis or prevent the development of malignant degeneration.

Surgical removal of the involved colon offers the only hope of permanent relief to those individuals with diffuse polyposis of the colon and rectum. In 1900, Lilenthal<sup>22</sup> successfully performed an ileosigmoidostomy followed by colectomy in a patient with this condition. Lockhart-Mummery,<sup>24</sup> in 1918, carried out a similar procedure with subsequent fulguration of the remaining rectal stump. Permanent ileostomy followed by the successful removal of the entire colon and rectum was recorded by Coffey<sup>8</sup> in 1923. The types of surgical procedures employed by a group of American and English surgeons in the management of their cases is listed in Table I.



surgical procedure, the mortality was 15.4 per cent. If one considers only the twenty-nine patients completely treated by ileostomy and colectomy or ileosigmoidostomy and colectomy, the mortality was only 6.9 per cent. This of course does not take into consideration those patients who may have subsequently died of recurrent malignancy but does establish the safety and importance of radical surgical treatment before carcinoma of the colon or rectum has developed.

#### CASE REPORT

The following case is recorded as a typical example of diffuse polyposis of the large intestine with malignant degeneration developing in young adult life.

Miss J., a school teacher aged 35, was first seen on September 5, 1939, complaining of colitis of seven years' duration. No other members of the immediate family had complaints similar to those of the patient. Three brothers and sisters were examined with negative findings.

Seven years previously the patient suddenly developed an acute attack of crampy abdominal pain associated with bloody diarrhea. She remained quite ill for three weeks and required six months to regain her strength. A second severe attack of abdominal pain with bloody diarrhea occurred five years ago. At this time hospitalization was necessary and a diagnosis of acute enteritis and colitis was made.

In the past five years there were intervals of freedom from diarrhea but overexertion or dietary indiscretion would usually precipitate a two or three day attack of crampy abdominal pain with blood in the stools. The patient's weight had remained constant.

Physical examination revealed a healthy young girl of stated age. Heart and chest were negative; blood pressure 122/80; the abdomen was flat with no scars or palpable masses. Tenderness was graded 2 plus in the right lower quadrant and 1 plus over the upper sigmoid colon. Rectal examination was negative.

Blood studies showed hemoglobin 76 per cent, red blood count 4,800,000, white blood count 13,700, polymorphonuclears 51 per cent, lymphocytes 46 per cent, monocytes 3 per cent.

Urine was negative and the stools were positive for blood.

The clinical impression was ulcerative colitis, possibly amebic in type. X-ray studies of colon were reported as follows: Barium enema showed rectal ampulla and lower sigmoid distended. There was an annular constriction in the midsigmoid region narrowing the lumen to a diameter of 1 cm. Numerous rounded filling defects were present in the sigmoid and descending colon which were very suggestive of polyps.

The x-ray diagnosis stated: "Extensive polyposis of the sigmoid and descending colon and possibly of the proximal colon as well although examination of this portion of the bowel could not be completely carried out. Annular constriction in the midsigmoid region interpreted as carcinoma. The possibility of inflammatory change is considered but seems very unlikely."

Exploration on September 11, 1939, revealed a typical constricting signet ring carcinoma in the midsigmoid. It was impossible to palpate any of the suspected polypi within the lumen of the colon. The mesenteric nodes were not enlarged and the liver appeared normal. An obstructive resection of an eight-inch section of the sigmoid colon was carried out, removing the tumor and its adjacent mesentery.

Convalescence was uneventful following this procedure except for a left saphenous phlebitis which rapidly subsided. During the post-operative period the sigmoid colon and rectum below the colostomy opening was examined by sigmoidoscope from below and through the colonic stoma. The entire mucosa extending down to a point within one inch of the anal ring was found to be studded with small mucosal polyps, sessile and pedunculated in type, varying in diameter from .25 to 1 cm.

The excised surgical specimen comprised a section of the sigmoid colon 20 cm. in length. (Fig. 1.) In its midportion was a typical adenocarcinoma 5 by 6 cm. in diameter, graded 2 by Broders' classification. The entire mucosa of the excised section was studded with multiple adenomatous polypi. No lymph node involvement was demonstrable.

On November 14, 1939, the colostomy stoma was closed. Healing was satisfactory and in January, 1940, the patient returned to her work as a teacher of physical education.

Recheck barium enema studies carried out in March, 1940, showed slight narrowing at the site of the previous obstructive resection. Multiple polypi were demonstrable throughout the sigmoid, descending, transverse and ascending colons, varying in size from 5 to 12 mm. A stereoscopic study of the colon made following evacuation and air injection demonstrated a generalized distribution of the polypi from the cecum to the lower rectum.

The patient was told of the nature of the condition and the possibility of further malignant degeneration. Resection of the entire colon was offered as a hope of permanent cure but a further period of expectant treatment was permitted at the patient's request.

On May 5, 1940, the patient was re-admitted to the hospital with the signs and symptoms of intestinal obstruction of twenty-four hours' duration. A flat abdominal plate confirmed the presence of dilated loops of small bowel and after preliminary decompression with suction, exploration was undertaken. A loop of ileum 15 inches above the ileocecal valve was found to be completely obstructed by an adhesive band. This was freed and the viability of the bowel demonstrated. At this operation there was no intraperitoneal evidence of recurrent carcinoma and again it was impossible to palpate the polypi known to be present throughout the colon.

Convalescence following this episode was uneventful and during the next eighteen months the patient continued at her work. Occasional bouts of abdominal pain occurred associated with diarrhea and the passage of polypi. Her strength, however, remained somewhat below par. Her blood picture was maintained at normal levels by the administration of iron and medication assisted in controlling the intestinal symptoms.

On December 27, 1941, the patient reported that she was feeling fine and only occasionally experienced some left lower quadrant discomfort. Her weight and blood picture were normal but occult blood was still present in the stools. Abdominal examination showed both incisions well healed. There was a suggestive area of induration palpable along the original incision just above the site of the primary obstructive resection.

Recheck barium enema was reported as follows: "Complete obstruction to the flow of barium encountered in upper mid-sigmoid

region. Barium and mineral oil given by mouth advanced slowly through the colon and appeared to pass through the constriction. There was a relative stasis of feces mixed with barium above the constriction in the sigmoid."

Comment: "Partial obstruction, probably neoplastic, of the sigmoid colon developing just above the site of the previous resection."

In view of this finding radical surgical extirpation of the colon was urged. After a suitable period of preparation, fulguration of the polyps from the anal region upward for a distance of approximately 12 inches was undertaken. On three occasions fulguration was carried out, destroying approximately 60 polyps. No anesthesia was necessary and the only discomfort experienced was that noted with fulguration of a few polypi in close proximity to the internal sphincter.

Recheck sigmoidoscopic examination on January 6, 1942, disclosed that all polypi in the lower 12 inches of the rectum and sigmoid had been completely destroyed with satisfactory healing at the site of fulguration.

On January 13, 1942, the abdomen was opened in the lower midline under spinal anesthesia. With considerable difficulty the descending colon was freed from the anterior abdominal wall at the site of the previous obstructive resection. The lower sigmoid colon was divided between clamps one inch above the peritoneal reflection. One or two small polyps seen in the distal loop were fulgurated in a retrograde manner. The terminal 18 inches of the ileum were extensively matted together as a result of the previous obstruction. Accordingly, the ileum was divided above this area and both ends carefully closed. The distal 18 inch section of ileum was returned to the abdomen to be removed with the cecum at a subsequent stage. The proximal ileum was anastomosed to the distal sigmoid loop in an end-to-side ileosigmoidostomy. The sigmoid and descending colon from the site of the anastomosis up to the splenic flexure was freed from its mesenteric attachments and brought out the upper angle of the abdominal wound. A Rankin clamp was applied one inch above the skin level and this segment of colon removed. Peritonealization of the left colic gutter was completed, 5 Gm. of sulfanilamide were left in the abdomen and the wound closed in layers with one pelvic drain and one drain emerging beside the exteriorized loop.

In spite of continuous venoclysis administered throughout the operation and a transfusion of 500 cc. of blood at its completion, the

seemed in suitable shape for the second stage of the resection. A moderate quantity of bloody mucus was occasionally expelled from the

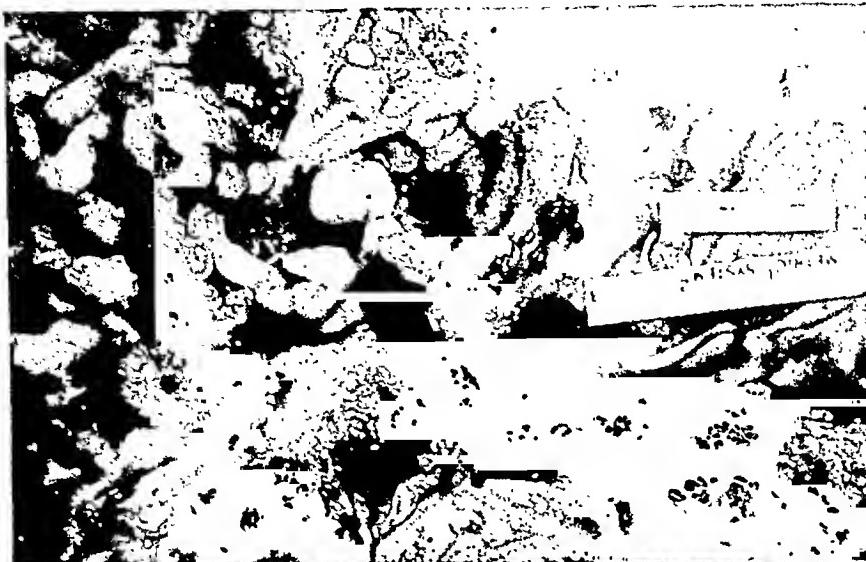


FIG. 1.

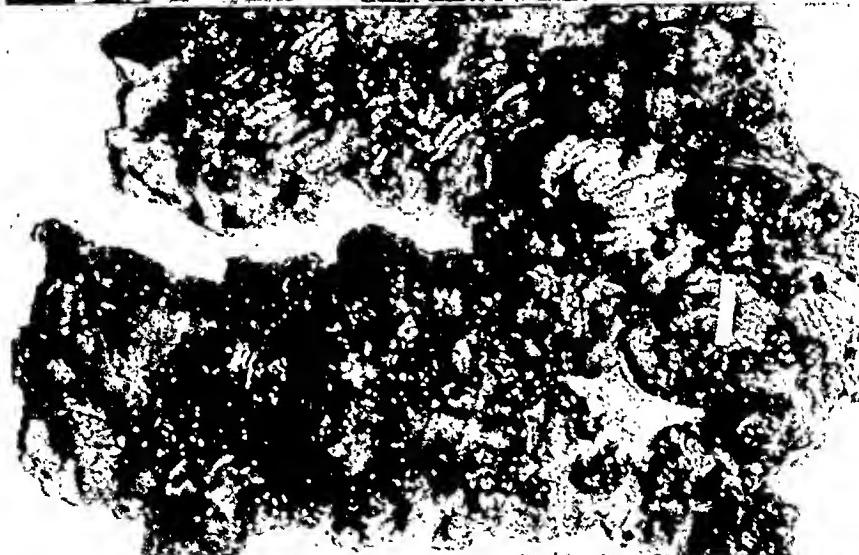


FIG. 2.

FIG. 1. Excised portion of sigmoid colon. Constricting carcinoma present with many mucosal polypi.

FIG. 2. Excised splenic flexure and transverse colon. Multiple polypi are noted, practically replacing the mucosa. Several of these polypi show early malignant change on microscopic section.

patient was in a moderate state of shock at the end of the procedure. She responded to a second transfusion four hours later and a satisfactory recovery following. The patient was dismissed from the hospital on February 1, 1942, the incision having healed by primary intention. At this time four or five liquid stools were being passed daily with very little abdominal discomfort.

On re-admission two weeks later the hemoglobin was 81 per cent and the red blood count 5,000,000. The patient looked quite well and

protruding loop of the splenic flexure in which numerous mucosal polypi were visible.

Resection of the splenic flexure and distal half of the transverse colon was carried out on February 12, 1942, under gas-ether anesthesia. A *t*-shaped incision was employed which greatly facilitated exposure of the splenic flexure and permitted removal of the exteriorized loop. The proximal transverse colon was brought out through the angle of the horizontal limb of the incision, closed by clamp and the freed section of the colon removed.

Five Gm. of sulfathiazole were left in the abdomen and sprinkled in the abdominal wound before closure. A transfusion was given

one drain in the retroperitoneal space. Five Gm. of sulfanilamide were left in the abdomen and sprinkled into the abdominal wound. The

FIG. 3.

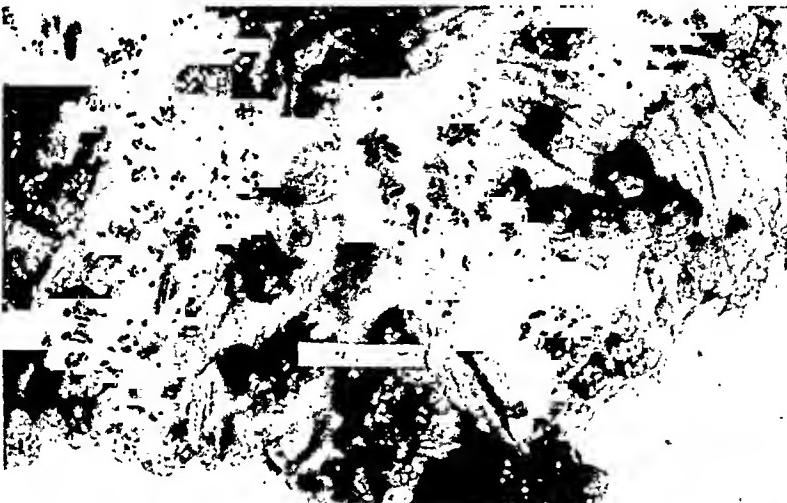


FIG. 4.

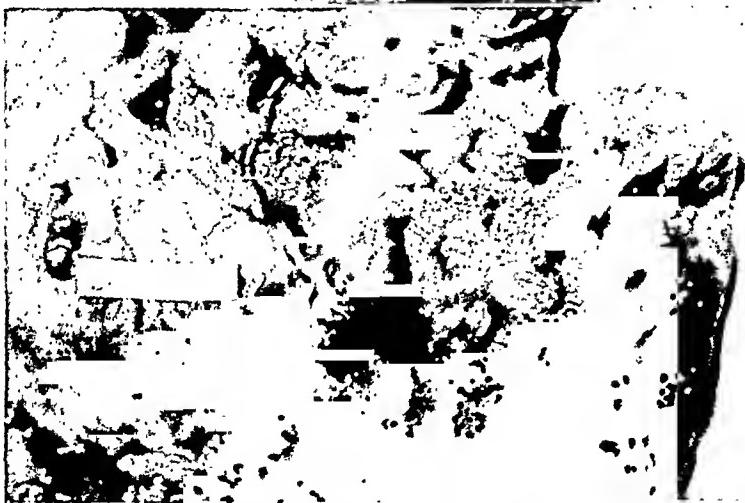


FIG. 3. Section of splenic flexure of the colon demonstrating the pedunculated character assumed by some of the larger polyps. This type of polyp frequently becomes separated from its pedicle and is passed per rectum.

FIG. 4. Portion of excised cecum and terminal ileum. Polypi were less numerous in cecum and ascending colon. A group of small polyps were noted in the terminal six inches of the ileum.

at the completion of the procedure. Convalescence was satisfactory and the wound healed by primary intention.

The final stage of the procedure was carried out on March 3, 1942, under spinal anesthesia. The terminal 18 inches of ileum, the cecum, ascending colon and hepatic flexure were mobilized and removed. Numerous adhesions between the ileum and the anterior parietal wall were freed and after peritonealizing the right colic sulcus the abdomen was closed with

patient was dismissed from the hospital on April 1, 1942.

Improvement was rapid following completion of the colonic resection. The patient gained twenty-five pounds in the next five months, enjoyed an excellent appetite, and prompt return in strength. Stools were now reduced to three per day.

Proctoscopic examination was carried out on September 1, 1942. The anastomosis between the lower sigmoid and ileum was

readily visualized 14 cm. above the anal ring with a well healed stoma 2.5 cm. in diameter. In the remaining rectum four small polypi were found and these were fulgurated. The patient now enjoys excellent health and has returned to her teaching duties.

Pathologic report on excised colon: Specimen of sigmoid and descending colon measured 25 cm. in length. Grossly there were multiple polypi and in the central portion was an ulcerating adenocarcinoma 4 by 5 by 3 cm. in size. Sections showed the tumor had penetrated the wall and was in the fat beneath the serosa. The cells were moderately differentiated. No lymph nodes were found. Diagnosis: Grade 2 adenocarcinoma of colon with multiple polypi.

The transverse and splenic flexure of colon measured 45 cm. in length. There were multiple polypi present, the largest being 5 cm. in diameter. (Figs. 2 and 3.) Sections showed numerous adenomatous polypi, several of which showed malignant degeneration.

The third specimen consisted of 25 cm. of cecum and ascending colon and 40 cm. of terminal ileum. There were multiple polypi in this specimen, the largest 3 cm. in diameter. (Fig. 4.) In the mucosa of the terminal three or four inches of the ileum were several small polypi similar to those seen in the cecum. Sections showed multiple adenomatous polypi.

#### CONCLUSIONS\*

1. The subject of diffuse polyposis of the large intestine is reviewed, adding thirty collected cases to those recorded prior to 1937.

2. This pathological entity develops on either a heredofamilial or an inflammatory basis, examples of the former occurring principally during young adult life.

3. Malignant degeneration may be expected to develop in practically all cases if they survive for a sufficient period of time.

\* Since completion of this report a further follow-up is possible. The patient remained entirely well until May, 1943, when evidence of ascites developed. Paracentesis has been necessary four times since that date, removing on each occasion from 4 to 5 liters of clear yellowish-brown aseptic fluid. Repeated efforts to demonstrate neoplastic cells in this fluid have been unsuccessful but the clinical course would indicate that widespread peritoneal metastasis is now present.

4. Surgical removal of the involved colon offers the only hope of permanent relief for these individuals.

5. The various types of operative procedures employed are outlined.

6. Colectomy in competent hands may now be undertaken with a very satisfactory operative mortality.

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# DUODENAL CARCINOMA

EDGAR BURKE, M.D.,

Chief Surgeon, Jersey City Medical Center

LOUIS L. PERKEL, M.D.

Attending Gastroenterologist, Jersey City Medical Center

AND

A. M. GNASSI, M.D.

Director of Laboratories, Jersey City Medical Center

JERSEY CITY, NEW JERSEY

**A**RARE case of duodenal carcinoma masquerading under symptoms of duodenal ulcer with an unusual clinical course, is herewith reported.

## CASE REPORT

E. D., a twenty-seven year old white brakeman entered the Jersey City Medical Center, October 21, 1937, on the medical service of one of us (L. L. P.) with a diagnosis of hemorrhage from a duodenal ulcer. This was his fifth admission to this hospital.

The history dates back to 1932 when he began complaining of epigastric pain coming on about four hours after meals and relieved by food or sodium bicarbonate. He consulted his family physician who prescribed a bland diet, alkaline powders, and belladonna. In the ensuing two years he had periodic remissions and exacerbations of symptoms.

In April, 1934, he was admitted to the hospital for a recurrence of the epigastric pain and vomiting. Roentgen study of the gastrointestinal tract revealed an irregular outline to the duodenal cap interpreted as representing a duodenal ulcer. Gastric analysis showed a moderate hyperacidity. After one month of strict medical treatment of the ulcer, he was discharged, considerably improved.

In September, 1934, he was readmitted to the hospital, again complaining of epigastric pain, vomiting and pallor. Findings at this time were epigastric tenderness, secondary anemia, and the presence of occult blood in the feces. Roentgen study showed marked pylorospasm, an irregular contracted duodenal cap with a definite crater arising from its inner border. (Fig. 1.) A diagnosis was made of a chronic perforating duodenal ulcer and again strict medical treatment was instituted with favorable response and the patient was discharged from the hospital in three weeks.

In 1935, he was admitted to the hospital for the third time, complaining of weakness, pallor and melena. One of us (E. B.) was called in consultation and found the patient to be markedly sanguinated. Again medical management together with several small transfusions relieved all the symptoms and the patient was discharged after four weeks.

Six months after this discharge, he was readmitted to the surgical service of one of us (E. B.) for an acute perforated duodenal ulcer. Simple closure of the perforation was done and recovery was uneventful.

For the following eighteen months, he was free of all symptoms and was able to resume his work as a brakeman. He then began to have epigastric pain which awakened him at 3 A.M., and was relieved only by vomiting. The symptoms became progressively worse for the following five weeks and on the day before the present (fifth) admission, he had a massive tarry stool associated with faintness. On the morning of the day of admission (October 21, 1937) he had a coffee ground emesis.

The patient's family history is of interest. One adult brother had had two severe gastric hemorrhages. Another brother is a patient with a roentgenologically proved duodenal ulcer, but has not been operated upon; neither has he, to date, had a gross hemorrhage.

A sister had had a gastrojejunostomy performed at another hospital for stenosing, intractable, duodenal ulcer.

Physical examination revealed a well developed, well nourished, pale white man, without any signs of marked weight loss. Examination of the head, neck, heart, and lungs was essentially negative. Blood pressure was 118/70; pulse 75. Examination of the abdomen revealed slight tenderness on pressure over the right upper quadrant. No organs or masses were palpable. Urinalysis was normal; blood Wasser-

mann reaction was negative; stools showed four plus occult blood; blood count showed 4.2 million red blood cells, and hemoglobin 85 per cent (Tallqvist).

arising from the lesser curvature border of the bulb. (Fig. 2.) Because of the presence of a pyloric obstruction and an intractable ulcer, as well as repeated hemorrhages, the patient



FIG. 1. Roentgen study showing marked pylorospasm, an irregular contracted duodenal cap with a definite crater arising from its inner border.

A diagnosis was made of a reactivated duodenal ulcer which was believed to be bleeding at this time. The patient continued to vomit and the vomitus contained clotted blood. He was put on a modified Sippy diet together with aluminum hydroxide gel. On October 26, a gastrointestinal roentgen study revealed a definite pyloric obstruction with a large gastric residue at six and twenty-four hours. There was also noted a large crater apparently

was transferred to the surgical service of one of us (E. B.). On October 30, 1937, a laparotomy was done with the following findings: The gallbladder was densely adherent to the anterior pyloric ring. As soon as this had been freed, a perforation as large as the tip of a finger was uncovered. It represents an active ulcer whose crater bottom had been the wall of the attached gallbladder. Another ulcer, of the same size, was situated directly opposite

on the posterior wall of the pyloric ring. This last named ulcer had burrowed into the head of the pancreas. The intervening pyloric ring tissue, situated between the two ulcers, was

resection of the stomach, with entero-enterostomy between afferent and efferent jejunal loops.

Pathologic Report: Grossly, the specimen



FIG. 2. Roentgen study showing definite pyloric obstruction with a large gastric residue at twenty-four hours. There is also noted a large crater apparently arising from the lesser curvature border of the bulb.

transformed into white, gritty scar, avascular, shrunken and without any elasticity. This scar tissue formation extended for at least  $\frac{3}{4}$  inch down the duodenum on each side (anterior and posterior). All the tissues of this area were much swollen and edematosly infiltrated. The condition had brought with it a high degree of pyloric stenosis. The operation consisted of an anterior, antecolic, Billroth II

consisted of a portion of stomach and duodenum, received in 10 per cent formalin, measuring 22 cm. in length, 8 cm. along the greater curvature and 9 cm. along the lesser curvature. The serosa was smooth except near the pylorus which revealed numerous fibrous tags. The first portion of duodenum revealed a saccular elevation of its wall with a minute perforation. It measured 1.9 cm. at



FIG. 3. Reduction of stroma and many glands lined with columnar hyperchromatic cells.

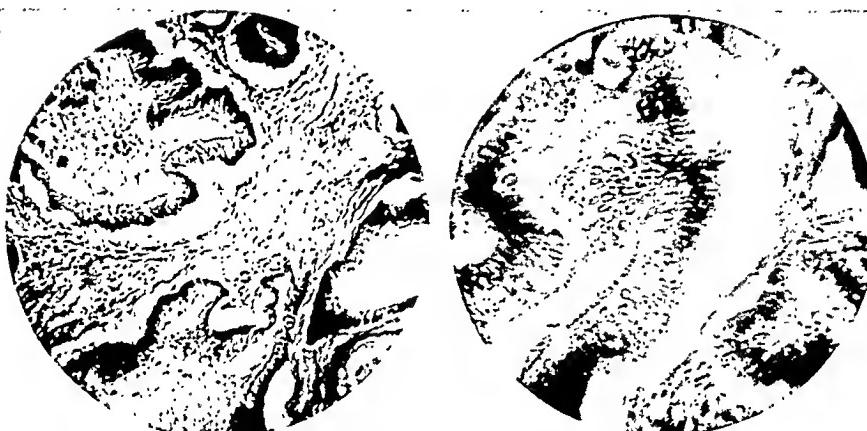


FIG. 4. Glands are larger and lateral sacculation are conspicuous.

FIG. 5. Cells are more aggressive and form papillae.

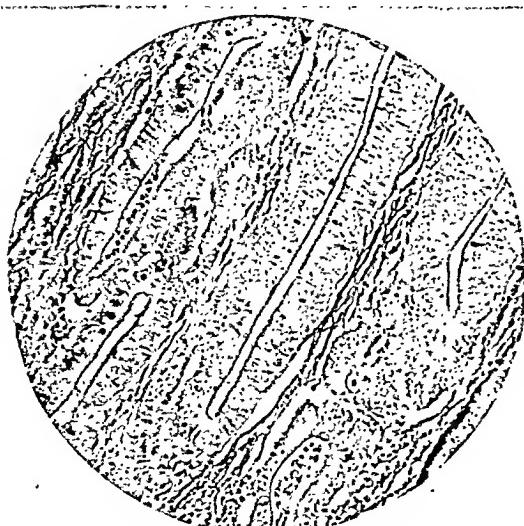


FIG. 6. Numerous tubular glands.



FIG. 7. Conspicuous number of mitoses.

its base and 0.6 cm. at its distal portion. On section, the gastric mucosa presented well formed rugae. At a distance of about 1.5 cm. from the pylorus, and within the first portion of duodenum, there was an ulcerated, oval area measuring 2.8 cm. The margins were thickened and the floor covered with a brownish, friable material. At its center, there was a stellated perforation which measured approximately 0.2 cm. Section revealed the distal portion of duodenum to be edematous, swollen, and the lumen markedly narrowed.

Microscopically, the sections showed the normal epithelium of the duodenal mucosa to change gradually into high columnar cells which had a finely granular cytoplasm, elongated nuclei with ever present increase of chromatin material. (Fig. 3.) At the ulcerated area, we saw giant acini with lateral saculations (Fig. 4) or papillomatous arrangement. (Fig. 5.) The cells were in a single row, but occasionally they proliferated to attain a thickness of two to three cell layers. At the crater of the ulcer, the tumor was chiefly composed of tubular glands (Fig. 6) with many mitotic figures. (Fig. 7.) The tumor extended down through the muscular but could not be traced within the serosal coat.

The patient made an uneventful post-operative recovery and was discharged from the hospital December 15, 1937.

Repeated roentgen studies of the gastrointestinal tract revealed no evidence of a

recurrence. The patient has uninterruptedly continued his work, and has had no complaints up to the present writing (March, 1943), a period of over five years since the gastric resection.

#### COMMENT

The clinical and laboratory findings to our mind justified the diagnosis of duodenal ulcer.

The pathological diagnosis revealed, not without some surprise to us, the true nature of the disease.

Its unusual clinical course merely emphasizes the fact that microscopical diagnosis cannot always predict the biological behavior of cells.

The presence of the neoplasm at the margins and crater of the ulcer excludes the possibility of a malignant degeneration of the latter and warrants the diagnosis of ulcerating adenocarcinoma.

#### CONCLUSION

A five-year cure of parapyloric duodenal carcinoma is reported.

We wish to thank Dr. F. W. Stewart, of Memorial Hospital in New York, for confirming the pathological diagnosis and for his invaluable help.



# ECTOPIC TESTIS—PUBOPENILE TYPE

CAPTAIN DANIEL R. KAUFMAN, M.C.

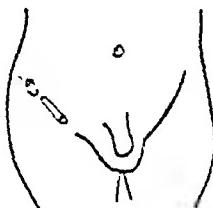
Station Hospital

FORT DEVENS, MASSACHUSETTS

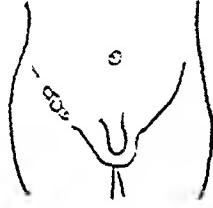
**I**N an extensive review of the literature by the Army Medical Library Staff and myself, no case report of the pubo-

To this day, many classifications of ectopic testis include the phenomenon of cryptorchidism. Many physicians still fail

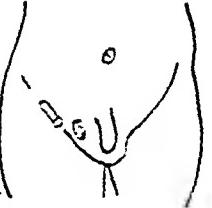
Abdominal Arrest



2. Inguinal Arrest



3. Upper Scrotal Arrest



## CRYPTORCHIDISM

S. R. Peacock.

FIG. 1. Diagrammatic representation of phases of arrest in cryptorchidism.

penile type of ectopic testicle has been found in the American Medical literature. All standard textbooks make mention of this rare phenomenon although the cases mentioned are taken from the foreign literature. At present, there are only five reported cases. Of the forms of ectopic testis, the penile type is, without doubt, the least common. If this type of case has been seen by our American colleagues, for some reason it has failed to find its way into American literature.

The condition was described as early as 1888 by Popow.<sup>3</sup> Following this, in 1897, there appeared a most extensive review of ectopic testes by Poupart<sup>4</sup> in his "Thesis." His classification was most complete and has changed in only a few details to date. Poupart's classification included cryptorchidism and ectopic testis as one condition. He classified them all under Ectopia as follows: (1) abdominal, (2) inguinal, (3) femoral, (4) perineal and (5) penile.

to differentiate between the two. Cryptorchidism, literally, means hidden testicle, and technically refers to the failure of a testicle to descend completely through the inguinal canal into the scrotum, its normal final habitat. Somewhere along its course of descent, there is an arrest. This occurs in the positions diagrammatically represented in Figure 1. Ectopia or aberrant location of the testis represents a distinct but related phenomenon. In this anomaly the testicle has descended completely, but veers from its course, and finally comes to rest in some abnormal situation.

To date, cases of abnormally located testes have been reported in the following aberrant positions (Fig. 2): (1) *Interstitial*: The testes, after leaving the external ring, passes upward and comes to lie on the aponeurosis of the external oblique. (2) *Pubopenile*: As in our case, the testis is found at the dorsum of the base of the penis, overlying the pubic bone. (3)

*Femoral or crural:* Scarpa's triangle on the medial side of the thigh becomes the final resting place for this testicle. (4) *Trans-*

The differentiation of the two terms will be further demonstrated in the history of the case to be reported. The patient

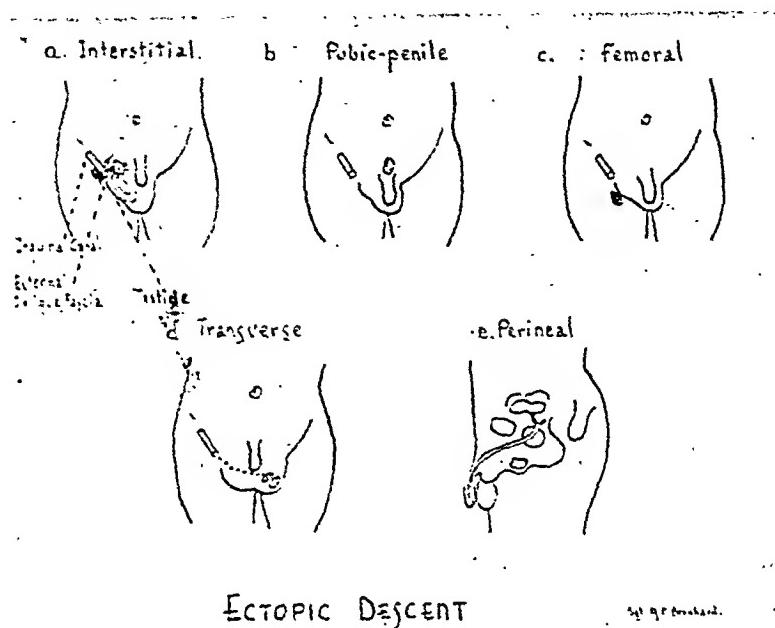


FIG. 2. Diagrammatic representation of various types of ectopia.

*verse:* In this type, both testes pass down the same inguinal canal and come to lie in the same scrotal sac. (5) *Perineal:* Here the testicle is found usually attached to the spine of the ischium and presents itself in the perineum.

The essential anatomical difference between cryptorchidism and ectopic testis is the foreshortening of the spermatic cord in the former, causing the arrest, whereas, in the latter, the cord is of sufficient length. This makes a great deal of difference in the ease with which the ectopia can be repaired as compared with the difficulty encountered in the repair of cryptorchidism. In the repair of the ectopic testicle, it is merely a matter of mobilizing the testicle and cord from its abnormal resting place and returning it to the scrotal sac. There is, as a rule, sufficient cord length to make this a rather simple procedure. However, in the cases of cryptorchidism, orchidopexy becomes a more difficult operative problem because of the necessity of operative lengthening the cord.

originally was a case of cryptorchidism, but at puberty, as is so often the case, the testicle descended. In its descent, it was diverted from its normal course, coming to rest in its preoperative ectopic pubopenile position.

#### CASE REPORT

Private W. H. was a twenty-one year old colored soldier admitted to the Hospital on December 21, 1942. He was first admitted to the genitourinary service for a small abscess of the skin, above and to the left of the base of the penis. He stated that this small painful area had been becoming worse for the past three days.

The only other significant history was that for the past five or six years he had noticed a soft mass at the base of the dorsum of his penis. He had never had a testicle in his right scrotum and, previous to six years ago, he thought he had felt a mass in his right side in the area of the right inguinal canal. He had moderate pain when he bumped his symphysis at any time especially when having intercourse. Other history was irrelevant.

The pertinent physical findings were limited to the genitourinary system. Just above, and to the left of the base of the penis, there was a

magnesium sulfate application and was improved in four days.

Because the position of this ectopic testicle

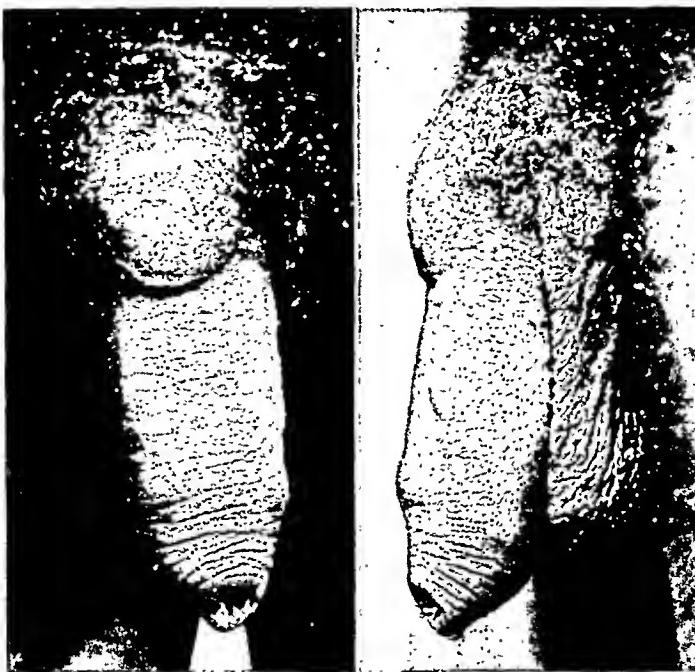


FIG. 3. Preoperative views of the right testicle; A, anterior; B, lateral.

small, well circumscribed, hard nodule in the subcutaneous tissue. Upon pressure, some purulent exudate was recovered. This was smeared and cultured.

On the dorsum of the penis, at its base, overlying the pubic bone, there was a soft, oval, discrete mass, having the consistency of a testicle. (Fig. 3.) This mass was rather freely movable and, on pressure, the patient complained of typical testicular pain. The right scrotum was underdeveloped and empty. The left scrotum and its contents were normal.

Admission diagnoses were furuncle, single, moderately severe, above the base of penis, and right ectopic testicle, pubopene type.

Urinalysis examination on the day of admission was essentially negative. Pus from the furuncle showed many pus cells with small Gram-negative pleomorphic rods.

Culture showed *Staphylococcus aureus*, *n. catarrhalis*, alpha streptococci, beta streptococci. The prostate smear and culture were negative for *N. gonorrhoea*; red blood cells, 4,410,000; hemoglobin 90 per cent.

The furuncle responded rapidly to hot wet

placed it in an extremely vulnerable position, it was my opinion that it should be placed in its normal site, operatively, to make this soldier capable of performing unlimited military duties.

On January 15, 1943, under spinal anesthesia, a right orchidopexy was performed. (Fig. 4.) A three-inch incision was made in the area of the lower right inguinal canal over the external ring down to the external oblique fascia. The cord was isolated and followed down to the testicle. The testicle was then mobilized and pulled upward. Extending from the lower pole of the testicle, there was a well defined gubernaculum. This ran downward and was attached firmly to the symphysis pubis at the dorsum of the base of the penis. This was mobilized, clamped, cut, and tied off with a No. 0 plain catgut suture. The testicle was then completely mobilized and isolated through the lower end of the incision. The testicle was found to be about three-quarters of its normal size. At this time, the scrotum was packed off with a gauze sponge to increase its capacity. The tunica vaginalis was then opened and a small amount

of clear yellow fluid was released. The excessive tunica vaginalis was excised and the edge sutured with a continuous No. 00 plain catgut

of this suture were put through the scrotum from the inside, going out through the skin, and were tied off on the outside of the scrotum.

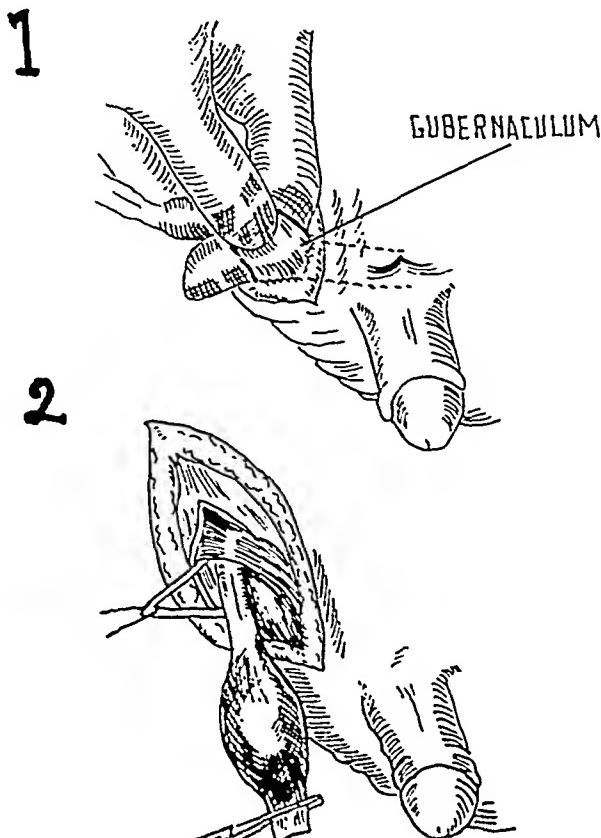


FIG. 4A.

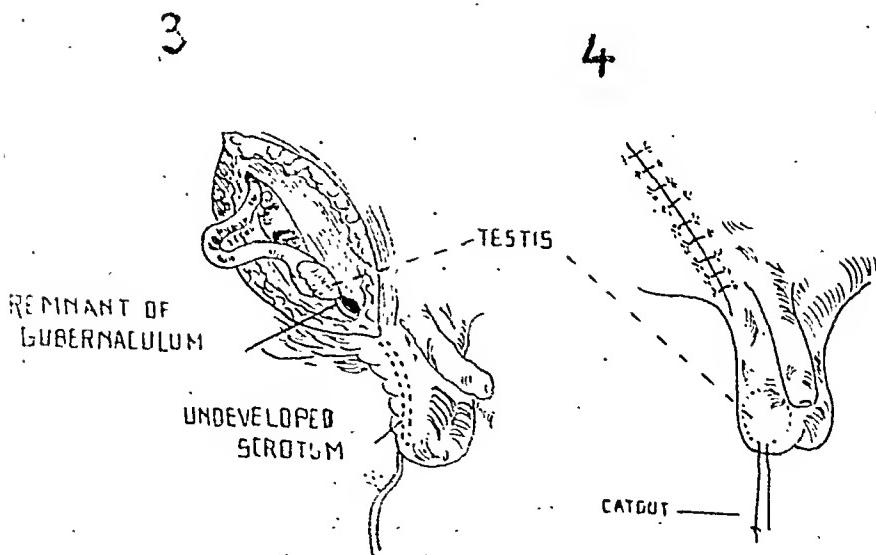


FIG. 4B.  
FIG. 4. A and B, steps in the operative repair.

suture. Following this, a No. 00 chromic catgut suture was placed through the tunica albuginea at the inferior pole of the testicle. Both ends

This anchored the testicle firmly into the right scrotal sac. There was easily sufficient cord length to assure replacement of the testicle

in its new normal habitat. The external ring was closed off with two interrupted No. 00 chromic sutures. The skin was closed with

the first case reported in the American literature, five other cases having been reported in the foreign literature.

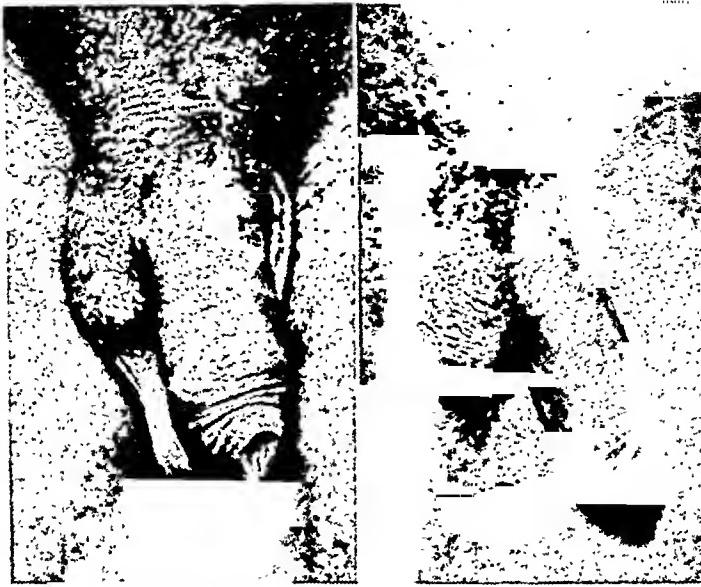


FIG. 5. A and B, postoperative views of the right testicle.

interrupted silk sutures. A dry sterile dressing was applied and the patient was returned to the ward in good condition.

The patient's postoperative course was uneventful. On January 21st, the sutures were removed. The wound was well healed and the testicle was well down in the scrotum. On January 30th, he was out of bed but experienced a little difficulty when he walked due to a slight pulling sensation in the operative site. This, however, disappeared and on February 3rd he had no complaints and the testicle was well situated in the scrotum. (Fig. 5.) He was discharged to full duty on February 15, 1943.

#### SUMMARY

1. A case of the pubopenile type of ectopic testis is reported and the operative technique for the repair is described. This is

2. The classification of ectopic testis is discussed and the limited literature reviewed.

The author wishes to extend his thanks to Colonel C. R. Haig, Commanding Officer, Station Hospital, Fort Devens, Mass., and Lt. Col. Gilbert T. Hyatt, Chief of Surgical Service, Station Hospital, Fort Devens, Mass., for granting permission to report this case.

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# CHRONIC LUNG ABSCESS\*

TREATED BY LOBECTOMY AS A METHOD OF CHOICE

ISIDOR KROSS, M.D.

Attending Surgeon, City Hospital

NEW YORK, NEW YORK

THE various procedures employed in the treatment of abscess of the lung are proof that this phase of the subject is far from a satisfactory solution. In spite of the intensive pioneer work of Wessler and Neuhof<sup>1</sup> and their associates, most acute lung abscesses are still treated expectantly or by methods that have been proved to be ineffective; i.e., chemotherapy, postural drainage, bronchoscopy, phrenic avulsion and pneumothorax. Wessler and Neuhof have showed very clearly that early surgical treatment of acute putrid lung abscess, properly carried out, is both simple and effective, and results in complete cure in about 96 per cent of the cases and carries only a 4 per cent mortality rate. Yet, in spite of the experience of these and of other investigators, expectant and so-called "conservative treatment" is still carried out to a considerable degree. This results in a high mortality among those patients who succumb to the disease in the acute stage and to the development of a chronic lung abscess in the greater part of those who survive. Since it is well known that only about 25 per cent of all putrid lung abscesses undergo spontaneous cure, the magnitude of the problem of chronic lung abscesses becomes quite apparent.

This was recognized by C. A. Hedblom<sup>2</sup> who writes that: "Localized uncomplicated abscesses that do not show unmistakable signs of improvement after a limited time should be treated surgically. A large proportion of such cases are treated expectantly over a fatal course, or eventually the patients present themselves for treatment *after irreparable damage* has been done. Such chronic conditions presenting multi-

locular or multiple cavitation involving often the larger part of the lung and with an associated bronchiectasis, often bilateral, and with secondary damage to the vital organs, *are among the most difficult* that confront the surgeon. In the more chronic cases, there is often extensive associated pneumonitis, fibrous thickening of both lungs and pleura, and bronchiectasis which *make either collapse or drainage treatment ineffectire*. For such cases the only treatment that offers a reasonable prospect of cure is extirpation of the diseased portion of the lung."

E. A. Graham<sup>3</sup> among others also emphasized the importance of this condition when he said: "Chronic suppurative non-tuberculous infections of the lungs constitute one of the most difficult therapeutic problems in the whole field of medicine. The inherent nature of the pathology of these conditions makes futile in most cases the same surgical methods which are applicable to the acute cases. Simple drainage is seldom of much avail because usually there is no single circumscribed abscess to be drained. Instead, there may be multiple abscesses in an indurated mass as if the lung were honey-combed with pus, or there may be dilatation and fibrosis of the bronchioles from each of which pus exudes, the condition usually spoken of as bronchiectasis. As a rule, in fact, a condition of chronic abscess and of bronchiectasis occurs simultaneously. Complete surgical removal of the diseased portion of the lung would be the ideal procedure theoretically if it could be made safe. The natural course of these chronic cases, after a period of prolonged

\* From the Surgical Service, City Hospital, New York City.

invalidism, is to end by death from a pulmonary hemorrhage, a cerebral embolism which usually results in an abscess

investigation and sputa examinations were consistently negative for tuberculosis.

His present illness began about one week

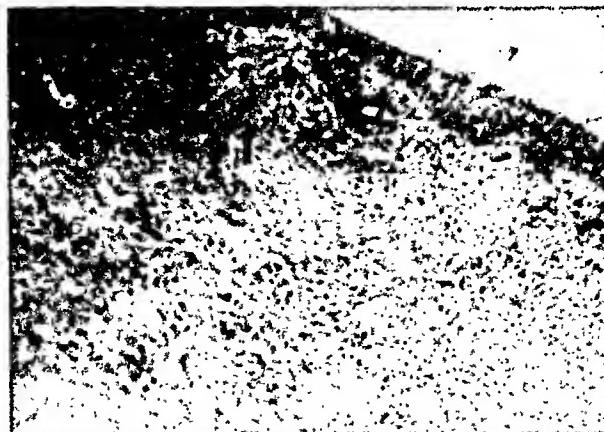


FIG. 1. Showing areas of subacute and chronic inflammation, total absence of pulmonary alveoli, and universal fibrous tissue fibrosis formation. Low power.

of the brain, an extension of the suppurative pneumonia, or from the effects of amyloid degeneration of the viscera."

In a recent publication Neuhof and his collaborators<sup>1</sup> again call attention to this subject and point to the high operative mortality and the low rate of cure in what they call "the diffuse type of chronic lung abscess."

Bearing all these facts in mind, when a patient with a chronic lung abscess was transferred from the medical service of City Hospital to the surgical division for operation, it was decided both by Dr. Milton Rosenblatt, chief of the Chest Clinic, and by the writer to attempt to eradicate the disease fully by lobectomy as a deliberate operation of choice.

#### CASE REPORT

The patient, N. C. No. 109804, age thirty-five, was admitted to the medical service of Dr. Whittemore and Dr. Dillon at the City Hospital on October 1, 1941. The family history is essentially negative. He was treated at the Harlem Hospital for the past two years for a gastric ulcer. During this time he had a moderate cough which was not constant. For this condition he was treated by the Board of Health Tuberculosis Clinic. Here x-ray

prior to admission with pain in the upper portion of his chest anteriorly. This pain was made worse on deep inspiration and on coughing. During this time he had a moderate amount of expectoration. There were no chills and no night sweats. His pupils were contracted and reacted sluggishly to light and accommodation. Many teeth were missing and his gums showed evidence of marked pyorrhea. Examination of the chest revealed numerous friction râles in the right axilla, upper half. The rest of his physical examination was essentially negative. The admitting diagnosis was pulmonary tuberculosis of the right upper lobe with pleurisy.

On October 2, 1941, he was examined by the attending physician who found that "physical signs are confined to the right apex indicating an infiltration simulating the reaction of an acid-fast lesion." The x-ray taken on that day (No. 84-6) shows the following. "There is consolidation involving the lateral two-thirds of the right upper lobe. A fluid level is present in the lateral portion below the first anterior interspace in the sub-clavicular region." The patient was immediately put on sulfathiazole treatment. On October 3, 1941, he expectorated an abundance of sputum with a very foul odor. This was noted by the resident physician, Dr. Eckstein, who suggested that the lesion might be a putrid lung abscess. On October 11, 1941, the bedside notes indicated a marked improvement in the appearance of the patient and a

reduction in the amount of expectoration, which now was no longer foul; temperature at this time was normal. X-rays (No. 8687 and

10342). His temperature on November 29, 1941, rose up to 103°F. On December 13, 1941, it was noted that the patient felt quite



FIG. 2. Showing dilated bronchioles, bronchiectasis with destruction of the epithelial elements and peribronchial fibrous tissue formation. High power.

No. 8524) showed a decrease in the size of the abscess and a clearing of the surrounding infiltration. A note on October 22nd states that the condition improved but the pulse still ranged between 90 and 120 per minute. On October 31st, an x-ray showed a still further decrease in the size of the cavity and a continued reduction in the extent of the pneumonic process. The pulse, however, was still rapid. A bronchosopic examination on November 19, 1941, reported the presence of a thickened carina and of an intensely reddened mucosa in the right upper lobe bronchus. The patient was also receiving postural drainage during this time and the progress note on November 16th read that the patient now "coughs infrequently and has only an occasional transitory pain in the right upper chest." On November 29, 1941, the patient developed severe pain in the right upper chest anteriorly which was made much worse on breathing and coughing. The temperature at this time rose to 103°F. Physical examination of the lung showed numerous crackling râles over the right anterior portion of the upper half of the chest. Breath sounds were diminished and percussion note was dull. A white blood count taken at this time showed 28,000 white blood cells and 62 per cent polymorphonuclears. X-ray taken now showed an increase in the pneumonic process and the presence of a cavity about one inch in diameter (No.

weak and that his breath had again become foul. He was now coughing much more than previously and raised considerable sputum. On December 23rd, the temperature had come down to normal where it remained for the next week and on December 30th he was discharged with instructions to appear in the follow-up clinic for observation. During the past two weeks he was advised to consent to operation but he refused to submit to operation.

He was readmitted on March 16, 1942, with a history that he had been feeling quite well until about three weeks prior to his second admission at which time he again developed severe pain in the right upper chest anteriorly. He was referred back from the follow-up clinic to the hospital for surgical treatment and was prepared for operation by transfusions for a general secondary anemic condition and by mouth hygiene to reduce the pyorrheal condition as much as possible. On April 11, 1942, a right upper lobe lobectomy was performed.

The right upper lobe was completely solidified. It contained one large shaggy walled cavity in the inferomesial portion perforating into the medial lobe fissure. There were recent adhesions at the interlobar fissure laterally, posteriorly and anteriorly. One old band adhesion laterally was seen.

An incision was made in the third right intercostal space from mid-axillary line to

sternum. The costal cartilage of the third and fourth ribs were partially excised. The pleural cavity was opened and the third and fourth

noted deep in the pulmonary parenchyma. The cavity measured  $2\frac{1}{2}$  cm. in its greatest diameter, filled by thick purulent material.

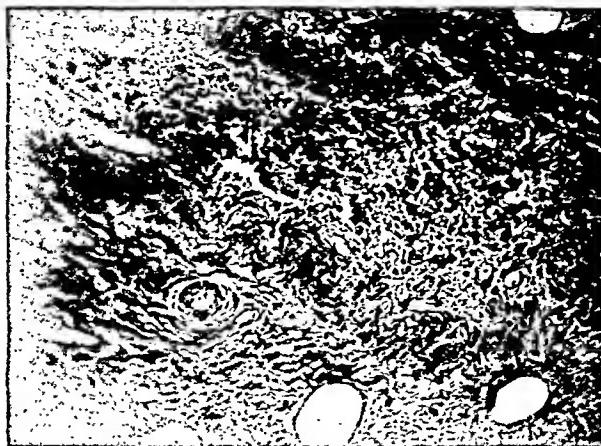


FIG. 3. Showing bronchiectasis, fibrosis and inflammatory changes. High power.

ribs severed subperiostially in the anterior axillary line to produce more exposure. The adhesions were separated. The old band adhesions were cut between ligatures thus mobilizing the entire lobe. A tourniquet was applied at the hilum of the upper lobe and the lobe was excised leaving a small pedicle containing a narrow zone of lung tissue. The pedicle was ligated with several mattress sutures and the tourniquet was removed after hemostasis was made secure. The space occupied by the upper lobe was filled with iodoform gauze packing and a mushroom catheter was introduced in the midaxillary line, fourth intercostal space for prophylactic drainage. Stout catgut sutures were applied pericostally around the third and fourth ribs. An interrupted layer of catgut sutures was applied to the muscles of the anterior chest wall and the skin was closed with interrupted silk sutures.

The specimen (labelled right lung, upper lobe) consisted of resected upper lobe of right lung whose visceral pleura was dull, granular, of pale grey to red color chiefly over the posterior broad edge. A fine fibrinous exudate covered the pleura in the same area. On the inferior surface an opening measuring  $2\frac{1}{2}$  cm. in its greatest diameter was noted in the pleura. The opening was lined by thick yellowish grey membrane. A probe placed into this opening lead into a large irregular cavity in the lung whose inner surface was markedly granular, of yellowish grey color. A second cavity was

Numerous dilated bronchi with markedly thickened walls were noted deep in the tissue. Several small sections of resected cartilaginous portions of rib were also noted.

Microscopically, the abscess cavity was lined by chronic granulation tissue with large areas re-epithelialized by columnar epithelium. The granulation tissue consisted of very cellular fibrous elements and densely packed plasma cells. The surrounding parenchyma was fibrous. There were small spaces lined by cuboidal epithelium and filled by hemosiderin-bearing phagocytes. A few small bronchioles were still present, the walls tremendously thickened and fibrous, the lumens small. Masses of elastic tissue were scattered here and there. The arteries had an intense proliferative endarteritis frequently with occlusion and recanalization. Beyond the abscess cavity the lung had many changes of fibrotic and inflammatory nature. There was an irregular fibrosis, both interstitial and involving exudate within alveoli. Many bronchi were dilated. Others had tremendously thickened and fibrous walls with small lumens. Many alveoli were filled with fibrinous exudate. At the hilum, the largest bronchi had many nests of squamous cells in the columnar epithelium. Diagnosis: Multiple chronic lung abscess. Dr. James R. Lisa, pathologist.

There was a postoperative reaction during which his temperature rose to  $102.8^{\circ}\text{F}$ . This gradually came down and on the sixth post-

operative day reached 99°F. His general condition during this time was quite satisfactory. From the sixth to the twelfth postoperative days his temperature again gradually rose until it reached 103°F. The wound was examined and the outer parts were found to be red, edematous and puffy. This portion of the wound was opened and a subcutaneous cellulitis was found in the soft tissues extending into the axillary space. This was packed and treated with sulfathiazole powder. His temperature gradually came down and on April 24, 1942, the patient was quite comfortable and had only a slight discharge from the wound. On May 1, 1942, the patient's temperature rose to 103.2°F. There had been a gradual rise from normal to this point during the past four days. There was a recurrence of coughing and expectoration. The upper portion of his chest was now tapped and thick pus was obtained. On May 2nd, a rib resection was performed and a small empyema pocket in the upper anterior portion of his chest was drained.

At operation a pocket of thick foul yellowish pus was located posteriorly and laterally beneath the eighth and ninth ribs. Under general anesthesia an incision was made posteriorly and laterally over the eighth rib. Sections two and one-half inches in length of the eighth and ninth ribs were removed. Intercostal vessels were ligated; pus was located and evacuated. One large semisoft rubber tube was introduced for drainage and connected to underwater bottle for drainage. Sulfathiazole powder was dusted into the wound and an iodoform gauze pack applied.

His temperature came down to normal within forty-eight hours and on May 25th progress note showed he was walking about and feeling quite strong. At that time a very small sinus tract was left at the site of drainage

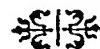
which held only about 5 cc. of fluid. General improvement continued and on June 16, 1942, the cavity was closed, the wound healed and the patient was discharged. He was kept under observation in the chest clinic and about a week after discharge the sinus reopened and some five days later a small sequestrum was extruded spontaneously. Twenty-four hours later the wound was closed. He has been under observation until the present time, has had no recurrence of his trouble, feels perfectly well and is doing hard laboring work.

#### CONCLUSIONS

This case exemplifies clearly the apparent spontaneous cure that is seen so frequently, that the attending physician is often lulled into a position of false security only to find later on to his great chagrin, that the patient had developed a chronic lung abscess. It also shows the irreversible pathological changes that set this condition so definitely in a class entirely apart from the acute abscess. It is the irreversible nature of these changes, fibrosis, bronchiectasis and multiple secondary abscesses that make free drainage, which is so effective in acute lung abscess, so unsatisfactory and ineffective in the chronic abscess. It is the nature of these changes that makes radical treatment—lobectomy—the sole rational method to be followed.

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# MASSIVE TRAUMATIC EVISCERATION\*

CASE REPORT

LIEUT. MARTIN LUTZ, M.C.  
U. S. Navy

HERBERT T. WIKLE, M.D.,  
Director of Surgery, Cumberland Hospital

AND  
ROBERT J. RYAN, M.D.  
Resident in Surgery, Cumberland Hospital  
BROOKLYN, NEW YORK

A REVIEW of the literature reveals few cases of massive abdominal evisceration in which the patients recovered. Most of the cases of evisceration occurred in individuals who had been stabbed, and inasmuch as such wounds are rather small, the amount of viscera extruded is proportionately little.

Harrington, in discussing evisceration, stated that the most common advice in first aid in evisceration is not to replace the intestines into the abdomen, especially if the intestines are leaking. However, if left outside, they dry and become fixed to any covering over them or there may be associated thrombosis or strangulation. It is, of course, imperative to reposit viscera if there is associated laceration of the diaphragm that permits entrance of air into the pleural cavity.

Ambrose Storck reported six cases of evisceration of a small amount of intestine or omentum in abdominal stab wounds. Three were associated with further trauma such as perforation of gut or injury to femoral artery and of these, two patients died. Others lived after reposition.

Louis Wright et al. reported thirty-one stab wounds of the abdomen in which there were no visceral injuries except evisceration of variable amounts of intestine in some of the cases (number of eviscerations undisclosed); in these there was a mortality of 9.6 per cent.

J. D. Marten, analyzing 250 cases of abdominal trauma, states that shock as a result of the injury, ranked second to

peritonitis as a cause of death, with internal hemorrhage as a poor third. He also stated that if shock is present spinal anesthesia should not be used because it increases peristalsis, therefore, more intestinal spill occurs if the bowel is perforated.

Of 180 of Marten's cases—all penetrating wounds of abdomen—123 had perforation of viscera; twenty-five had evagination of intestines on the belly wall. Contrary to what might be expected, mortality from injury to the liver, kidney and spleen was 70.7 per cent, whereas mortality for hollow viscus injuries was 39.2 per cent. The combined mortality rate was 46.6 per cent.

George G. Davis observed that bayonet wounds of the abdomen in World War I rarely came to the operating room. In 1915 and 1916, in France, he saw but one bayonet wound of the abdomen in a series of 2,525 cases under his care in an Evacuation Hospital. He concludes that bayonet wounds are nearly always fatal; death occurs most likely from hemorrhage.

T. C. Bost reports an unusual case. An eighteen-year old male was impaled on a piece of timber which caused intestinal perforation requiring resection. Peritonitis and obstruction resulting postoperatively requiring enterostomy. A suppurative peritonitis developed, which required drainage; later a necrotic external carotid artery was tied off and recovery followed.

Ambrose L. Lockwood states that in wounds of the abdomen in civilian life at

\* Read before the Brooklyn Surgical Society, February 5, 1942.

least 65 per cent of the patients who come to surgery should recover.

Eisberg, in thirty-four cases of penetrat-

the scene enlarged the wound and reposed the viscera, closing the wound without drainage. No aseptic precautions were



FIG. 1. Showing omentum, stomach, transverse colon and small bowel eviscerated.

ing abdominal wounds, had nine deaths, most of whom had visceral injury.

Revelle, while in China, saw a soldier who had been stabbed in the abdomen five days previously. From a five-inch wound just above the umbilicus there protruded a large purulent mass, which required "two hands" to enclose it and was covered with omentum. Because of infection, treatment was conservative; the mass gradually receded into abdominal cavity and the patient recovered.

Lord Moynihan states that penetrating wounds with laceration of the liver have two serious features: hemorrhage and sepsis. If hemorrhage is fatal, it is usually so in twenty-four hours. The right lobe is injured six times as often as the left.

Davies was called to see a native youth who had been injured a few hours previously. The patient was lying in mud with several loops of small intestine protruding through a wound about the size of his index finger. Davies did not think he could do much for the patient, but decided he might try something. He returned for his surgical instruments and upon reaching

followed aside from clean rubber gloves and no anesthesia was administered. The patient wanted to eat the next day and had an uneventful recovery. He was up and about on the tenth day.

#### CASE REPORT

CASE No. 98778. The patient, O. B., a nine-year old male of Puerto Rican parentage was admitted to the Cumberland Hospital, October 16, 1941. His past history was essentially negative aside from an uncomplicated lobar pneumonia in 1939.

While roller skating, he was struck in the abdomen by the ragged and torn fender of an automobile. An ambulance was called which responded immediately and returned to the hospital with the patient. The entire elapsed time of the call was thirteen minutes.

Examination immediately after admission showed a well developed, well nourished, white male about nine years of age who was unconscious, extremely pallid and who did not respond to stimulation. Pulse and blood pressure were not obtainable. Respiratory movements of the chest wall were present but were slow and shallow. There were several superficial lacerations and abrasions of the scalp, covered with blood but not actively bleeding. Examina-

tion of the abdomen showed an extensive laceration with some avulsion of the entire thickness of the abdominal wall. The laceration



FIG. 2. Patient four weeks after closure of abdomen.

extended from the upper and outer region of the right upper quadrant medially across the midline to the lateral border of the left rectus muscle. Though the wound was covered with blood, there was no active bleeding on admission. Protruding through the wound and lying on the abdominal wall were the stomach, the transverse colon omentum, several loops of small intestine and in the right upper portion of the wound were a few ragged pieces of lacerated liver. On admission the extruded viscera were found covered with a fairly clean kitchen towel, though a few small pieces of the boy's clothing were found lying among the coils of gut. No other injuries were grossly apparent.

The patient was immediately given shock therapy including external heat, and he was placed in Trendelenburg position. He had received morphine sulfate gr.  $\frac{1}{6}$  en route to the hospital. Coramine and caffeine sodium benzoate, one ampoule each, and 2 cc. of 50 per cent magne-

sium sulfate were given intramuscularly. One cc. of adrenalin was given in the right brachial artery. A venous cutdown in the left antecubital fossa was rapidly done and an infusion of saline was begun. Five hundred cc. of plasma were quickly added to the infusion; 10 cc. of adrenal cortical extract were given via the rubber tubing of the infusion apparatus. The extruded viscera were covered with several combines moistened with normal saline. Gradually the pulse and color returned and one and one-half hours following admission the patient's blood pressure was 140/86, pulse 120 and of good quality. The skin was warm and the patient was conscious. The boy was immediately prepared for operation.

Under open drop ether anesthesia the abdominal wound and surrounding skin were prepared with ether and tincture of merthiolate. The skin edges were débrided. The protruding viscera were cleared of all gross dirt and particles of clothing followed by copious irrigation with normal saline and 1,000 cc. of an 0.8 per cent solution of sulfanilamide. The viscera were examined and the only grossly traumatized member was the liver. The intestines and stomach were replaced. The lacerated liver was repaired with three mattress sutures of chromic atraumatic catgut. Six Gm. of equal parts of sulfanilamide and sulfathiazole powder were placed in the peritoneal cavity and the wound. The abdominal wall, excepting the skin, was closed with through-and-through figure-of-eight chromic No. 2 catgut sutures. The abdomen was not drained. A rubber tissue drain was placed in the right lateral angle of the wound and the skin edges were approximated as well as possible with interrupted black silk sutures.

Immediately postoperatively, the patient's condition was rather poor and he showed a rapid, feeble pulse with a blood pressure of 98/60. The continuous infusion was maintained and along with coramine, adrenal cortical extract and blood transfusion, his condition gradually improved and remained good. At this time he was given 3,000 units of tetanus antitoxin and 1 ampoule gas-gangrene antiserum.

The next day,  $\frac{1}{2}$  Gm. sulfathiazole every four hours was started by mouth and continued for the following eighteen days, during which the patient received a total of 53 Gm. During this time his blood sulfathiazole concentration was maintained at about 3.0 mg. per cent.

The patient's course during the first few postoperative days was somewhat stormy. He was semi-stuporous and showed a temperature elevation between  $100^{\circ}$  to  $102^{\circ}\text{F}$ . His abdomen was moderately distended but this was controlled with prostigimin and Wangenstein drainage. On the second postoperative day he was placed on a postoperative feeding régime used in gastrointestinal cases.

The boy's subsequent course was marked by a persistent low grade temperature and an extensive wound infection which involved skin and subcutaneous tissue and which yielded *Staphylococcus albus* on culture. He frequently complained of pain in the right hypochondrium, and an abdominal flat plate on the fourteenth hospital day showed a marked elevation of the right diaphragmatic leaf which was most probably due to a gross intra-abdominal condition. During this time he was treated with occasional blood and plasma transfusions, parenteral vitamin C and hematinics.

His condition progressively improved and his wound was completely healed on the forty-sixth hospital day.

The low grade temperature and slight tenderness in the right hypochondrium continued until the seventy-fifth hospital day. A flat plate of the abdomen at this time showed a

comparative return to normal of the contour of the right diaphragmatic leaf.

The patient was discharged on the eighty-first hospital day. The only notable findings at this time was an area of weakness in the abdominal wound.

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# GIANT CELL TUMOR OF THE PATELLA\*

## CASE REPORT

MAX A. LEVINE, M.D.

Assistant Professor of Orthopedic Surgery, College of Medical Evangelists

LOS ANGELES, CALIFORNIA

THE presentation of the following case is made because of the rarity of the giant cell tumor in the patella.

and Chuinard.<sup>2</sup> Their addition made it the fifteenth reported case.

It is interesting to note that in the cases



FIG. 1. Lateral roentgenogram shows large cystic defect in the patella. Note the near break through at the articular surface of the patella.

In addition this case is interesting because of the earliness of the lesion. Very few cases have so far been reported with as little involvement of the patella. The most complete review of the literature was ably presented by S. Arthur Linde.<sup>1</sup> At that time he added a case to thirteen already reported. The last case of giant cell tumor of the patella was reported by Dillehunt

reviewed by Linde, that reported by Dillehunt and Chuinard, as well as the case that is being presented by the author, trauma had been a predominate factor.

## CASE REPORT

M. L., Jr. a white male, thirty-one years old, was seen at the office April 6, 1942. His chief complaints were, moderate pain over the

\* From the Orthopedic Departments, College of Medical Evangelists, and Cedars of Lebanon Hospital.

medial aspect of the right knee and severe pain on pressure of the right "knee cap." Duration was approximately one year, shortly following

as well as the capsular surfaces of the patella were in tact and no evidence of any disorder was noted, except for a "derby hat" feeling



FIG. 2. Gross specimen. Section showing the multiloculated cystic defect involving approximately two-thirds of the marrow.

a fall on his knee while playing ball. The patient stated that even slight pressure on his knee always caused considerable discomfort.

Physical examination was essentially negative except for the right lower extremity. Atrophy of the right thigh was one-half inch. The right knee was  $\frac{1}{4}$  of an inch greater in circumference than that of the left. The right calf presented three-fourths of one inch atrophy. There was no limitation of motion except for the last ten degrees of passive hyperflexion which was also painful. No patellar asymmetry or enlargement could be noted with the naked eye.

Anteroposterior and lateral view radiographs of the right knee were taken which revealed an irregular cystic lesion occupying approximately two-thirds of the patella. (Fig. 1.)

Excision of the patella was advised, however, the patient was not admitted to the Cedars of Lebanon Hospital until June 18, 1942.

A sterile twenty-four hour preparation of the right upper extremity was done. This was followed by the operation of the right knee on June 19, 1942. Through a paramedian incision, the right knee joint was exposed. The articular

of the anterior surface. This was due to the extreme thinning of this surface by the tumor. With a scalpel the cortex was entered and the tumor was noted to occupy at least two-thirds of the patella. The entire patella was excised. The capsular ligaments were approximated with chromic mattress and purse-string sutures. The repair was well tested with forty-five degree passive knee flexion. Further closure was completed and the right leg was placed in a plaster of paris cylinder cast extending from the groin to the ankle.

The pathological report by Dr. Reuben Strauss stated that the specimen consisted of a patella, apparently from an adult. The articular surface presented nothing remarkable and the anterior aspect showed evidence of dissection. There was a small defect, 15 by 8 mm. on the anterior aspect which appeared to be an artefact. The edges of the defect were sharp. It communicated with a cystic defect involving the marrow. On section there was a multiloculated cystic defect involving approximately two-thirds of the marrow. These locules were lined by a smooth, grayish-white membrane which showed considerable reddish-brown dis-

coloration. The cancellous bone of the marrow elsewhere was normal in appearance and consistency. (Fig. 2.)

osteoclasts. This tumor tissue was moderately vascular. In the area moderate amount of osteoid tissue could also be seen and some

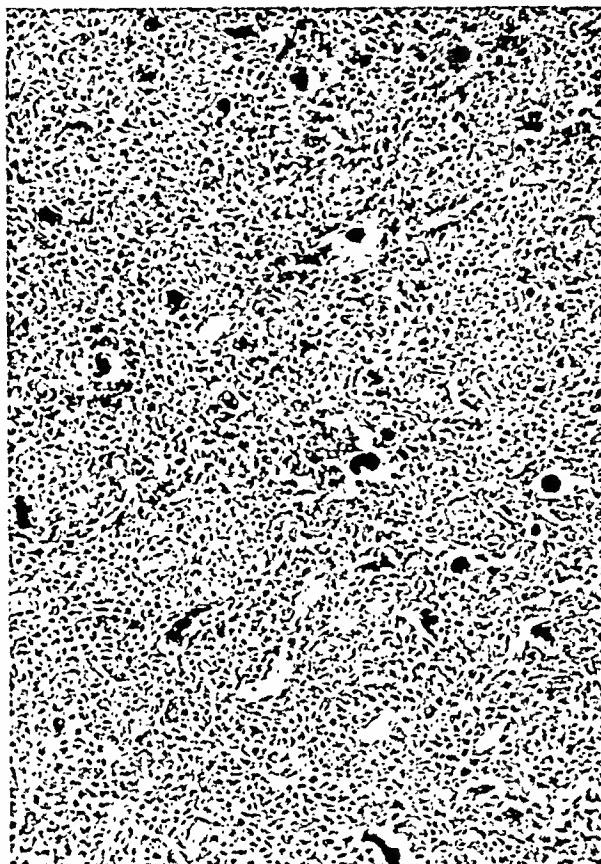


FIG. 3. A microphotograph showing numerous giant cells resembling osteoclasts scattered among a relatively large amount of tumor tissue composed of spindle cells. This tissue is quite vascular.

Microscopically, multiple sections of the tissue revealed a striking picture. In some areas the marrow spaces were very large and filled with adipose tissue which in places presented slight focal fibrosis and round cell infiltration. Some of the fat cells appeared to have coalesced to form large vacuoles. In some areas there was extensive fibrosis and round cell infiltration with evidence of new bone formation. Many of the bone lamellae were lined by numerous osteoblasts. Those lamellae bordering the cyst cavities showed no osteoblasts on that aspect of the lamella bordering the cyst. Lining the cyst cavity could be seen a relatively large amount of tumor tissue composed of polymorphic hyperchromatic spindle cells. Scattered among these cells were numerous multinucleated giant cells greatly resembling

newly formed bone lamellae. In some areas the tumor cells were surrounded by a homogeneous hyalin matrix resulting in the impression of immature cartilage formation. Few mitotic figures were seen. (Fig. 3.)

**Diagnosis:** Cystic giant cell tumor of the patella (benign).

The postoperative course was uneventful. Six months after surgery the patient has no pain or discomfort. The range of motion is angle of greatest extension 180 degrees, angle of greatest flexion 70 degrees, and flexion range is continuing to improve.

#### COMMENT

1. The case presented compares favorably with the usual age of average patient

with giant cell tumor which is between twenty-nine and thirty years of age.

2. In every case trauma has been a predisposing factor. Some pathologists consider a benign giant cell tumor as a granuloma resulting from an organization of a rather extensive hematoma in the bone marrow. This concept would bear out the clinical analysis of trauma in almost every case reported.

3. Unlike the majority 10:5 this case is of a male.

4. Excision of the patella is the treatment of choice and has the most successful results.

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EVERY severely wounded person is shocked, especially if there is accompanying soft tissue damage and hemorrhage such as occurs with compound fractures. Shock should be anticipated and prevented as much as possible. When the patient is severely shocked, the general treatment must have precedence over local treatment.

From "Fractures and Dislocations for Practitioners" by Edwin O. Geckeler (Williams & Wilkins Company).

# ACUTE COMPLETE DUODENAL OBSTRUCTION

## CASE REPORT

LEON SOLIS-COHEN, M.D.,  
Radiologist, Jewish Hospital

NORMAN J. SKVERSKY, M.D.  
Medical Resident, Jewish Hospital

PHILADELPHIA, PENNSYLVANIA

SAMUEL LEVINE, M.D.,  
Associate Radiologist, Jewish Hospital

JERRY ZASLOW, M.D.  
Resident in Pathology, Jewish Hospital

**T**HIS case is reported because of two unusual features: (1) The rarity of the cause of mechanical obstruction, which was a cluster of calcified, tuberculous retroperitoneal glands; and (2) the enormous gastrectasis, developing within forty-eight hours after the acute onset of symptoms, the stomach occupying the entire peritoneal cavity.

### CASE REPORT

A seventeen year old white male was admitted to the hospital with a history of sudden onset of acute pain, colicky in character, on the day prior to admission. One bout of vomiting occurred and the pain was continuous. Enemas and paregoric were ineffectual and the abdomen became quite distended. Following breakfast, at home, several more bouts of vomiting occurred. The vomitus was described as semibrown and greenish, containing masses of undigested food. The past history was significant, as it revealed a Potts' disease of the spine existing since fourteen months of age. Otherwise it was negative in all respects.

Physical examination revealed an acutely ill patient, dyspneic, and orthopneic, associated with cyanosis of the lips and nails. Abdominal distention was marked. There was evidence of a kyphoscoliosis of the thoracic area with a curved, longitudinal scar at the site of operation. Tachycardia was present, the rate being 160 per minute. Systolic pressure was 120. Diastolic pressure was unobtainable. There was no audible abdominal peristalsis, but cardiac and breath sounds could be auscultated through the anterior abdominal wall. A right-sided, reducible, indirect hernia was noted.

Laboratory studies showed the following: White blood count, 13,900; 84 per cent polymorphonuclear cells; blood carbon dioxide 36 per cent by volume; blood chlorides 360 Gm.

The patient's course was rapidly downhill. Treatment consisted of Wangensteen suction (drainage was a semisolid greenish-brown material), intravenous glucose in normal saline solution and blood plasma intravenously. An oxygen tent was employed but the patient expired four hours after admission.

The anteroposterior view (Fig. 1) shows a tremendously dilated stomach associated with dilatation of the first portion of the duodenum. The shadows of the small and large bowel are erased by the shadow of the air-filled stomach. Only a small vestige of gas is observed in the rectum. Probably the small intestines and colon are completely collapsed mechanically by the dilated stomach.

The lateral view (Fig. 2) shows the gastric wall so thinned out as to resemble a pneumoperitoneum. A kyphoscoliosis of the vertebral column is noted.

### DIFFERENTIAL DIAGNOSIS

1. It is inconceivable that a loop of either large or small bowel can be dilated to the extent of the existing gastric dilatation.
2. Shadows of large or small bowel loops are absent.
3. The duodenal cap and the lesser and greater curvatures of the stomach are so sharply delineated as to point unquestionably to a retroperitoneal obstruction of the duodenum.
4. The specific cause of the obstruction is suggested by the shadow of a calcified gland at the site of the obstruction. Associating this fact with the known presence of a tuberculous spine, diagnosis points toward tuberculous glands as the cause of the obstruction.

At the postmortem examination the body was that of a young adolescent white male. There was a marked kyphosis of the thoracic

region with a generalized underdevelopment of the rest of the body. The abdomen was

dominal cavity was entered with ease and the peritoneal cavity had no exudate. However, at



FIG. 1. Note calcification at pyloric ring. Abrupt ending of distended duodenum and enormous dilatation of stomach filling entire peritoneal cavity.

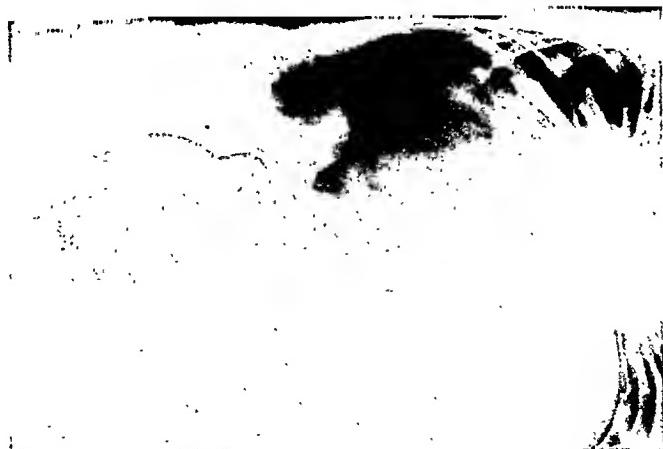


FIG. 2. Dorsal decubitus position. Observe dilated stomach simulating a pneumoperitoneum.

markedly distended. Only an abdominal incision was permitted.

The incision was started just above the pubis in the midline. For the first 4 cm. the ab-

this point, beneath the peritoneum and extending back almost to the spine, a smooth, obstructing mass was felt. In attempting to cut the peritoneum over this mass, the latter was

cut into, and there was a gush of liquid brown material, similar to that obtained on Wangensteen drainage before death. As soon as this was done, the obstruction was no longer felt and the rest of the abdomen was easily opened. The peritoneal serosa was smooth and shiny, with no evidence of inflammatory changes.

The gastric mucosa was hemorrhagic with beginning local ulceration. The rest of the bowel was normal in colon. There was a constriction on the posterior wall of the duodenum below the pylorus due to dense calcified nodules (5 to 10 cm. in diameter) with semicaseous material in some areas. The other organs showed marked underdevelopment.

Microscopy confirmed the gross autopsy findings. The retroperitoneal glands produced complete duodenal obstruction.

#### CONCLUSIONS

Neither the clinical nor x-ray findings were in line with a diagnosis of nonobstructive acute dilatation of the stomach. In acute dilatation of the stomach there would be no erasure or absence of intestinal or colonic gas outlining the various portions of the gut. The stomach outline would be smaller. A cursory search of the literature failed to reveal any similar report.



WHILE carcinoma of the duodenum is exceptional, carcinoma of the stomach is one of the captains of the men of death. Four thousand persons die annually from this disease in Britain, and nine thousand in America (Sherren). Males are twice as often affected as females.

From "A Short Practice of Surgery" by Hamilton Bailey and R. J. McNeill Love (H. K. Lewis & Co. Ltd.).

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## Editorials

### THORACIC SURGERY AFTER WORLD WARS I AND II

IT has become more or less axiomatic that surgery of the chest came out of the first World War. Many presume that thoracic surgery will become perfected in World War II.

In these days of catastrophic and rapidly changing events it might appear inappropriate to attempt to predict the status of thoracic surgery after this present war. And it might appear on first thought that there is little to be achieved by such an attempt. Retrospective consideration, however, of the development of surgery of the chest after World War I may indicate that there is something to be gained by evaluating the reasons and trends which have brought about this development. The average physician and surgeon might better acquaint himself with his place or responsibility in the future development of chest problems by such an evaluation.

*Until the possibilities of a science become somewhat generally appreciated by scientists, that science cannot be said to have reached even an adolescent stage.* It might be stated that thoracic surgery began its adolescence when Evarts Graham and his co-workers proved during the influenza epidemic of the last war that mediastinal flutter was being produced by surgeons who were resecting segments of ribs before postpneumonic thin pleural effusions had become purulent. This demonstration

directed the minds of most of the profession to a chest problem which confronted them frequently in civilian practice. And, furthermore, it gave them tangible knowledge *wilbin their own province of therapeusis*, a worth while therapeutic principle most of them could apply themselves if need be. As a consequence, the general profession came to realize that thoracic surgery perhaps could have a wider practical application than they had suspected previously.

If the value of a medical science is in direct proportion to the number of the profession who are able to apply its possibilities in a diagnostic and therapeutic way, it is easy to understand and explain why thoracic surgery has a long way to go before it reaches its maturity, a state of maturity comparable to that of abdominal surgery. Brunn's consecutively successful lobectomies for bronchiectasis (a procedure which previously had been essentially discarded because of the high mortality rate attending it) reported in 1928, Evarts Graham's magnificent accomplishment of total pneumonectomy for carcinoma of the lung in 1933 which will stand as a golden milestone of achievement, Garlock's original report of three consecutively successful resections of the mid-portion of esophagus for carcinoma, contributions to the surgery for tuber-

culosis, these and accomplishments by other distinguished men whose names will live indefinitely but of whom space will not permit mention here, fired the imagination and the enthusiasm of many and resulted in a tidal wave of dramatic accomplishment in the chest field during the past fifteen years. But so far, the execution of major, thoracic, surgical procedures has been beyond the surgical environment of many men. Well co-ordinated teams, including those especially trained in anesthesia, in the technic of bronchoscopic aspiration and postoperative inhalation therapy, are necessary for most major intrathoracic procedures. Such teams have not been nor will they be available to the majority for some time to come.

The average surgeon, pressed as he is by everyday problems, has not only found the performance of thoracic surgery beyond his scope, but has failed to inform himself and become sufficiently conscious of the early signs and symptoms of many surgical disorders of the chest. Most men have failed to realize that their own vista of usefulness in the field of early diagnosis and treatment of even less difficult and more frequently occurring surgical chest problems than carcinoma of esophagus or bronchus, has been widened markedly. The present great need in the profession as a whole is for correction of this latter phase of the problem.

During the present war those younger surgeons who serve in the battle zones especially, will become inculcated with knowledge and experience pertaining to wounds of the chest. Only a very limited number of surgeons situated in certain centers will have the opportunity to deal extensively with varied thoracic surgical disorders. But nevertheless many will return from the war, conscious that certain problems of chest surgery belong within their own therapeutic domain even under ordinary environmental conditions.

In the first two decades which will follow this war, surgeons who previously would not have attempted surgery for lung

abscess will resect segments of the ribs for this disorder under local anesthesia, doing a one-stage operation (according to localization principles of Neuhof and Touroff) as easily and effectively as they have previously resected a segment of rib for empyema. Fewer patients will die from tension pneumothorax after an automobile accident with a mistaken diagnosis of "shock." He who neglects an acute post-pneumonic empyema will be labeled, as he is to some extent now, as a charlatan or an ignoramus. And sufficient stimulus will arise to develop gradually the realization of the general profession to its diagnostic responsibility.

The general profession will begin to appreciate that it does not suffice for one to make a diagnosis of lung abscess or empyema, that the causes of these disorders are varied and the etiologic agent should be specified in the diagnosis if possible; that, for example, carcinoma of the lung may be the etiologic agent in both; that the bacteriology in lung abscess and in empyema varies and may make considerable difference in therapeutic indications; that our conceptions of therapy for tuberculous, straw-colored effusions have changed in recent years, (that such effusions are no longer left in the pleural cavity indefinitely upon the theory that they should be so left to keep the lung at rest); and that "unresolved pneumonia" is an almost obsolete term being replaced by more specific reference to etiology and pathology.

Though some surgeons in this war may see more blood in a month than they have ever seen before, or suture a thousand wounds a month, the problems of disease, of malignancy, of trauma, will remain closely interwoven with the complexities of anatomy, physiology, bacteriology, chemistry, and pathology. And those who master the diagnosis or therapeutics of thoracic problems must of necessity think in terms of these great sciences. The war surgeon of today who thinks in this manner as he performs his surgery can do much

to stimulate the profession at home tomorrow where stimulus is most needed.

Surgery of the chest has probably outgrown a stage at which a single discovery, as that of the U. S. Empyema Commission of the last war, can so profoundly affect its development. Surgery of the chest will

reach its maturity as the general profession fashions its methods of thought regarding chest problems on a pattern of fundamental sciences in a diagnostic way, as it now does regarding the diagnostic problems pertaining to abdominal surgery.

J. K. DONALDSON, M.D.

## PLASTIC SURGERY IN THE ARMY\*

**I**N reply to an article which I read before the American Society of Plastic and Reconstructive Surgery in December, 1942, and which *The American Journal of Surgery* quoted editorially in its issue of September, 1943, Major General Norman T. Kirk, Surgeon General of the United States Army, complains that the implications of my article are "absolutely unfounded and unjustifiably animadversional." He further intimates that insufficient effort was made by me to ascertain the true situation. In view of this criticism I am constrained to present the following facts:

1. My paper, as stated above, was presented at the annual meeting of the American Society of Plastic and Reconstructive Surgery in December, 1942. The advances in the organization of the Army's program for plastic surgery, which the Surgeon General cites, were inaugurated according to his own statement, "many months ago."

2. Before preparing this article, I wrote to the Office of the Surgeon General for

information on the then-status of plastic surgery in the Army. The reply dated September 25, 1942, stated that "It will be impossible for this office to collect any data on the present status of Plastic and Reconstructive Surgery in the Armed Forces at this time" and referred me to the Sub-Committee on Plastic and Reconstructive Surgery of the National Research Council. I pursued the suggested avenue of inquiry without success. In fact, in February, 1943, I was authoritatively informed that this committee had no information as to the fate of its suggestions to the Surgeon General's Office.

3. In June, 1943, three months before the editorial in question was published, a copy was sent to the Office of the Surgeon General. I received an acknowledgment dated June 14, 1943, which in no way questioned the accuracy of my statements or suggested any corrections therein.

Since my sole interest in this problem is the proper organization of military facilities for plastic surgery, I am gratified by the outline of such facilities by the Surgeon General. I am citing the above facts merely to show that I did make every effort to ascertain the true status of the Army's organization for plastic surgery and that the Office of the Surgeon General had full opportunity to make any corrections they desired before publication of the editorial.

JACQUES W. MALINIAC, M.D.

\* The editor is not responsible for the views expressed by the authors of articles appearing in the Journal. It has been the custom when some one wrote the editor criticizing or commenting on material in the Journal for the letter to be sent to the author of the article for his personal reply and comment. In the above instance we violated this rule and published Major General Kirk's criticism. Therefore, in all fairness, we are publishing Dr. Maliniac's reply. As far as we are concerned, this closes the issue.



# Original Articles

## PROGRESS IN THE MANAGEMENT OF HEMORRHOIDS

EDWARD T. WHITNEY, M.D.

Surgeon-in-charge, Rectal Clinic,  
Boston Dispensary

AND

GASPAR ANGELO, M.D.\*

Assistant Surgeon, Rectal Clinic,  
Boston Dispensary

BOSTON, MASSACHUSETTS

MUCH progress has been made in the treatment of hemorrhoids since suppositories and the clamp and cautery were the sole forms of therapy. In fact, we now know that suppositories are practically worthless except, possibly, as a palliative measure and the treasured pearl-handled cautery clamp gathers dust in the usual hospital display of antique instruments. And yet, there is a surprising amount of confusion among the medical profession as to just what hemorrhoids are and as to how they should be handled.

### A PLEXUS OF VARICOSITIES BENEATH REDUNDANT MUCOUS MEMBRANE

A hemorrhoid is a redundant pouch of rectal mucous membrane or anal skin containing a plexus of varicose venules. Early recognition of the fact that it is a plexus of very small varicosities and not one large vein will banish some of the confusion. Furthermore, an understanding of the genesis of such a condition will also help but this requires a knowledge of certain aspects of the anatomy, physiology and pathological states of the anus and lower rectum.

### THE VEINS INVOLVED

The closure of the anus is accomplished by the tonic contraction of the sphincters which causes the mucous membrane of the much larger rectum to be thrown into a number of folds called the columns of

Morgagni. Beneath the mucous membrane of these columns, there is a vast network of venules which collects the blood from this region and delivers it into the portal venous system by way of the superior hemorrhoidal veins. This blood has to be raised approximately a foot from anus to heart and yet no part of the portal venous system is protected by valves.

Furthermore, the superior hemorrhoidal veins lie for the most part within the abdomen on the walls of the rectum but, just above the location of the columns of Morgagni, these veins penetrate these walls to enter the rectum where they then lie just beneath the mucous membrane of the latter. (Fig. 1.) Above this penetration they are protected by the intra-abdominal pressure but below it they, at times, lose this protection as, during defecation, straining at stool and forcible breaking of wind, when this pressure is exerted against all of the contents of the rectum including any redundant mass of varicosities. It is no wonder, therefore, that these little thin-walled veins easily succumb to any factors tending to produce prolonged dilatation and varicosity whether the latter are confined locally to the portal venous system or whether they affect all the more dependent veins of the body.

### GENESIS OF THE VARICOSITIES

Those factors which tend to produce prolonged over-dilatation within the portal

\* Statistics in the text referring to the Cambridge Hospital were compiled by Dr. Angelo who is in charge of the Rectal Clinic at the Cambridge Hospital, Cambridge, Mass.

venous system alone accomplish this by increasing the intravenous pressure within that system. This over-dilatation is seen behind an hepatic cirrhosis, behind a cardiac decompensation, in alcoholism, overeating, etc. On the other hand, conditions which tend to produce varicosity generally throughout the more dependent veins of the body, do so by weakening the vein walls so that the latter are unable to withstand the normal intravenous pressure. The latter agents may be either nutritional or endocrine.

Nutritional deficiencies produce both atony of the smooth muscle and atrophy of the connective tissue sheath of the vein wall with ensuing weakness of both. An example of an endocrine influence may be seen in the excessive dilatation of the veins of the legs and anus during pregnancy, a condition which, we believe, is caused by the secretion of the hormone relaxin during this period.<sup>1</sup> This hormone is intended to produce relaxation of the ligamentous, capsular and other connective tissue attachments of the pelvis in order to mobilize the latter somewhat in preparation for delivery. The same effect exerted on the connective tissue structures of the veins would explain the marked increase of varicosities during pregnancy. The end result of any one or combination of these processes is the production of a plexus of varicose venules beneath the mucous membrane of the columns of Morgagni in the lower rectum.

#### GENESIS OF THE REDUNDANCY OF THE MUCOUS MEMBRANE

However, another process must occur before this state of varicosity is productive of a hemorrhoid; the mucous membrane and skin overlying these venule varicosities must become redundant. The mucous membrane and skin of the rectum, anus and peri-anum are fixed in various degrees to the latter structures and these fixations have to be stretched or abolished before the mucous membrane and skin can become redundant and form a pouch. The abolition

of these fixations is brought about by various forces singly or in combination. The varicosities themselves do considerable dissecting beneath the mucous membrane and the same nutritional and endocrine factors which weaken the vein walls also weaken these fixations and allow the varicose dissection to progress even more easily. Straining of course helps.

#### INFLUENCE OF THE CONJOINED LONGITUDINAL MUSCLE

This process of detachment can proceed rapidly beneath the mucous membrane of the rectum and beneath the peri-anal skin but not so rapidly in the region of the anus itself which is the reason why we have several different kinds of hemorrhoids; internal, external, prolapsed, etc. The skin of the anus has inserted into it the conjoined, longitudinal muscle of the bowel wall which fixes it very firmly to the sphincters at the intermuscular septum.<sup>2</sup> (Fig. 1.) This muscle is a continuation and confluence of the longitudinal bands of the large intestine and of the levator ani. It completely surrounds the lower rectum, ensheathes the three portions of the external sphincter and then becomes inserted principally into the skin of the anus at and just below the intermuscular septum.<sup>10</sup> The firm fixation of the anal skin in this region prevents the downward extension of the varicose process which started in the columns of Morgagni so that for some time the process is confined to the rectum and is called an internal hemorrhoid. (Fig. 1.)

However, if the redundancy of the mucous membrane in this region becomes extreme, it may form so large a pouch that the latter can prolapse down through the lumen of the anus thereby producing a prolapsed, internal hemorrhoid.

On the other hand, in some individuals the strands of longitudinal muscle inserted into the skin of the anus can be overstretched<sup>3</sup> by straining and separated by the dissecting action of the venules themselves, thereby allowing extension of the

process into the peri-anal area where once more the skin is loosely attached and once more a redundant pouch is easily produced

preceded and produced by an internal hemorrhoid.

Finally, in some individuals, the internal

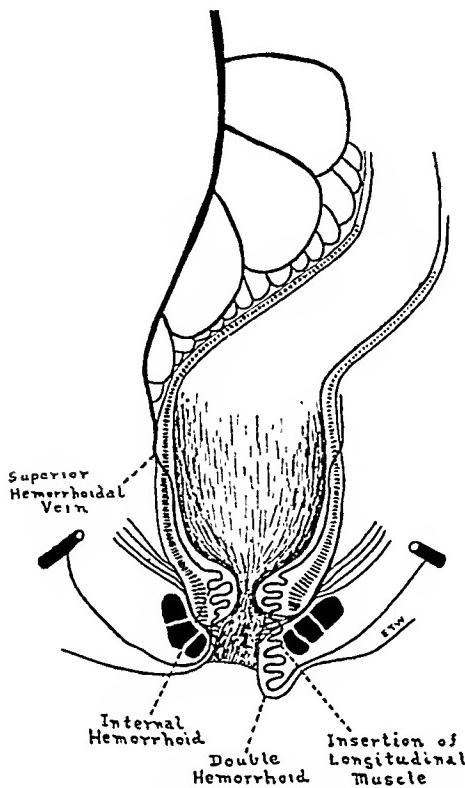


FIG. 1. A diagram illustrating two types of hemorrhoids by means of a sagittal section down through the rectum and anus. On the left is a simple internal hemorrhoid while on the right a double hemorrhoid is depicted. It will be noted that the superior hemorrhoidal vein pierces the rectal wall just above the hemorrhoids to lose its intra-abdominal support and become subject to the strains and stresses of the lower rectum and anus. The insertion of the conjoined longitudinal muscle into the skin of the anus is indicated and it will be seen how this controls the progress of the hemorrhoidal process and consequently governs the type of hemorrhoid produced. On the right, this insertion has been pierced and weakened and the skin has been detached from the anal wall allowing the formation of an external hemorrhoid as well as an internal one.

but this time wholly extra-anal. When this occurs, in addition to the internal hemorrhoid, we have an external hemorrhoid. (Fig. 1.) Such a condition, however, is really a double hemorrhoid as an external hemorrhoid rarely exists without being



FIG. 2. A prolapsed double hemorrhoid. The dark colored mass in the center is the dusky red, internal hemorrhoid which has intussuscepted down through the anus. This is surrounded by the lighter colored, external hemorrhoids which have really been transformed into fibrotic skin tabs.

part of such a double hemorrhoid becomes so redundant that it also intussuscepts through the lumen of the anus producing a prolapsed, double hemorrhoid. (Figs. 2 and 9.)

There are, therefore, four varieties of hemorrhoids: internal, prolapsed internal, double and prolapsed double. The external thrombotic hemorrhoid (so-called) is seldom a real hemorrhoid. It is nothing more than a thrombosis within some peri-anal venules. It really should be simply called an external thrombosis.

#### INJECTIONS VERSUS OPERATION

This much of the pathological process and anatomy must be kept in mind when it comes to selecting the proper method of therapy. The majority of proctologists treat hemorrhoids by both injections and operation depending upon the type of hemorrhoid encountered so that in this article, we shall not consider the other more rarely used methods such as "electrolysis" (galvanism), diathermy, etc. The

question is constantly being asked as to where the line should be drawn between those cases suitable for injection and those

or so above this line. Injection must be made above this demarcation line of sensation otherwise pain and sloughing

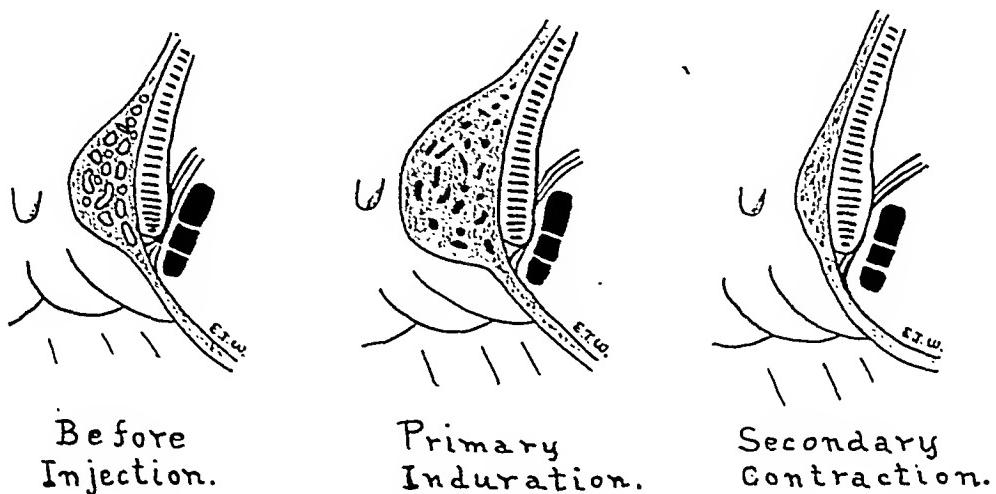


FIG. 3. Diagrams illustrating the effects of an injection on an internal hemorrhoid. The diagram on the left represents a redundant pouch of varicosities prior to injection. The middle one portrays the primary reaction following injection. Sclerosis of the varicosities and induration of the spaces between them has taken place. On the right is shown the end result. The sclerosed veins have been absorbed and the induration has been transformed into fibrosis which has contracted and, in addition to further obliterating the vessels, has reattached the mucous membrane onto the rectal wall.

requiring surgery. As will be seen subsequently, some definite rules can be made to govern this selection.

#### MANAGEMENT OF SIMPLE INTERNAL HEMORRHOIDS

Most all simple uncomplicated internal hemorrhoids can be obliterated by injection with suitable chemicals.<sup>4,5,6</sup> How long this obliteration remains or how long other unobliterated veins in the rectum remain free from varicosity varies with the individual. Usually, examination and injection routinely every few years maintains control of the condition.<sup>5</sup>

The injection is made into the internal hemorrhoidal mass or pouch as high up as possible. No attempt is made to put the solution into a vein; the veins are too small for this. Theoretically, there are no nerves of sensation above the mucocutaneous (pectinate) line which is at the level of the internal sphincter about one-fourth inch above the intermuscular septum. Practically, however, it is found that there is some sensation for about one-fourth inch

will occur. From this statement it can be inferred that no injection can be made directly into the external hemorrhoid and, therefore, any attempt to cure the latter by injection must be made via obliteration of the internal hemorrhoid. As this mucocutaneous line is somewhat indistinct at times, we usually advise the novice to ask the patient if he feels the touch of the swab putting antiseptic on the spot where the needle is to be inserted and, if he does, the injection must be made higher up.

Large boggy internal hemorrhoids may have to be injected two or three times<sup>3,4,7</sup> and this should be done systematically, the first injection being introduced into the uppermost pole and subsequently, after the lapse of a suitable time varying with the type of solution used and the amount of contraction obtained, a second or third injection is made lower down or just to either side.

There are two solutions in general use: 5 per cent phenol in vegetable oil and 5 per cent quinine and urea hydrochloride. From 1 to 5 cc. of the phenol in oil and from 1 to

2 cc. of the quinine is the usual dosage. Most proctologists give the other more widely advertised solutions a trial but



FIG. 4. A photograph illustrating two types of external hemorrhoids. The upper, bluish, patulous hemorrhoid is soft and reducible and would be benefited somewhat (perhaps markedly) by injections. The lower, lighter colored mass is hard and fibrotic, is irreducible and would be affected in no way by injections. However, operation is indicated on both types in the absence of contraindications, as even in the upper hemorrhoid the insertion of the conjoined longitudinal muscle has been irreparably weakened and detached allowing easy recurrence.

something usually turns out to be unsatisfactory. These two solutions have stood the test of time and experience.

Following the injection, there is a primary induration of the tissues beneath the mucous membrane composed of edema and inflammatory cells (mostly round cells). This primary induration can be palpated as a semi-firm lump on the wall of the rectum. (Fig. 3.) With the quinine solution, this lump disappears in a few days or at the most in a couple of weeks but with the phenol it lasts for a month or two which is the reason why we, personally, prefer the former. Sometimes several injections must be made in rapid succession and, if each one produces a lump and if each lump remains in existence for several weeks, the lumen of the rectum soon becomes so surrounded or filled with lumps that evacuation becomes difficult.

Following this primary induration, there occurs a flattening of the hemorrhoid due to fibrous contraction about and obliteration of the varicose venules. (Fig. 3.) Reattachment of the mucous membrane onto the rectal wall will take place if the fibrosis is extensive enough within the hemorrhoid to contact the muscle of the wall. In a large internal hemorrhoid, this does not always occur at first as the first injection produces only a ball of fibrosis in its center which must be fixed to the muscle by one or more subsequent injections. This fact is often overlooked.

#### MANAGEMENT OF PROLAPSED, INTERNAL HEMORRHOIDS

Contrary to expectation, a simple, prolapsed, internal hemorrhoid will often completely disappear upon injection especially if it is not too big or not of too long standing. It is surprising to see an angry, secreting, polypoid, prolapsed, internal hemorrhoid disappear within a day or two of an injection of its upper pole. Recurrence in two or three years will often follow however<sup>3,5</sup> but, if the primary fibrosis is made firmly adherent to the rectal wall by repeated injections and, if routine injections are made periodically every year or two, control of the condition can usually be maintained. In case of repeated recurrence or in old, large prolapses, operation is necessary. The latter is almost painless as it simply consists in transfixing the mass as high up as possible and excising it. As this all takes place above the mucocutaneous line where sensation is absent or nearly so, very little discomfort or disability results.

#### MANAGEMENT OF DOUBLE HEMORRHOIDS

Often an external hemorrhoid will be improved as the result of injecting the internal one. The fibrous contraction and reattachment following an injection pulls from all directions. Sometimes this is enough to cause a slightly redundant, external hemorrhoid to pull up in. This obliteration, however, may not be perma-

ment and only in early cases will it occur anyway. Remember that this injection does nothing to the overstretched insertion of the longitudinal muscle, so that, dissection of a new varicosity down through the latter is easily and quickly possible. Of course, one might simplify the problem of whether to operate or to inject by insisting upon operation on all double hemorrhoids. However, especially in regards to clinic patients, various reasons are constantly arising for avoiding operation such as contraindications, insufficient money, unavailable time, etc. We, therefore, have formulated the following rule to cover such cases: If the external hemorrhoid is reasonably small, is soft, is reducible and is of a normal or bluish color, injection of the internal hemorrhoid may be tried although the patient should be told that a permanent cure by this method will probably be unattainable. On the other hand, if the external hemorrhoid is quite large, is irreducible or is fibrotic or grayish in color (Fig. 4), or if the internal hemorrhoid has also prolapsed (Figs. 2 and 9), operation is definitely indicated and, furthermore, is insisted upon.

#### PERCENTAGE OF CASES IN WHICH PATIENTS MUST BE OPERATED UPON

Having thus roughly outlined which patients may be handled satisfactorily with injections and those which must be operated upon, it becomes pertinent to know what percentage of each are ordinarily encountered in proctologic practice. Consequently, we have reviewed the classification of 1,056 consecutive patients coming into the Rectal Clinics of the Boston Dispensary and the Cambridge Hospital. The results of this review can be seen by referring to Table 1. It will be noted that 615 or 58 per cent of these patients had hemorrhoids. Of the latter, 161 were double hemorrhoids, the majority of which needed operation. This is 26 per cent of all the hemorrhoids or 15 per cent of the total 1,056 rectal patients. Our percentage of double hemorrhoids is low as compared

with other previously reported statistics since all of the cryptic tabs<sup>8</sup> which were formerly diagnosed as double hemorrhoids have been cleaned out of the clinic. There

TABLE I\*  
DIAGNOSIS ON 1,056 CONSECUTIVE ADMISSIONS INTO  
THE BOSTON DISPENSARY AND THE CAMBRIDGE  
HOSPITAL RECTAL CLINICS

By Groups	Cambridge	B.D.	Both Camb. and B.D.	Per Cent
Hemorrhoids (primary diagnosis).....	87	323	410	.39
Cryptitis, fissures, fistulas, etc.....	52	220	272	.26
Recto-sigmoidal pathology.....	28	99	127	.12
Pruritis-ani.....	15	104	119	.11
Thromboses, misc., exams.....	18	110	128	.12
Total.....	200	856	1056	1.00
Hemorrhoids (secondary diagnosis).....	32	173	205	

#### CLASSIFICATION OF THE ABOVE HEMORRHOIDS ACCORDING TO TYPE

	Com- bined	Per Cent
Internal (simple).....	438	.71
Internal (prolapsed).....	16	.03
Double (simple and prolapsed).....	161	.26
Total.....	615	1.00

\* It will be noted in the upper part of the table that of the 1,056 consecutive cases, 410 had "hemorrhoids" as the primary diagnosis while an additional 205 cases also had hemorrhoids although the latter were secondary to some other more urgent condition. All together, of the 1,056 cases, there were 615 or 58 per cent which had hemorrhoids. In the lower part of the table, these 615 hemorrhoids are classified according to type. It will be observed that some 26 per cent of them were double hemorrhoids in which operation had to be considered. This is 15 per cent of the total 1,056 cases.

were also some sixteen patients with prolapsed internal hemorrhoids, some of which, may become or even may have already become surgical cases but, as any definite information on this is as yet

unavailable, they have not been included in this consideration.

This review, therefore, shows that ap-

comfort and prolonged disability from the hemorrhoidectomy operation. It is a matter of making the operation as simple as pos-

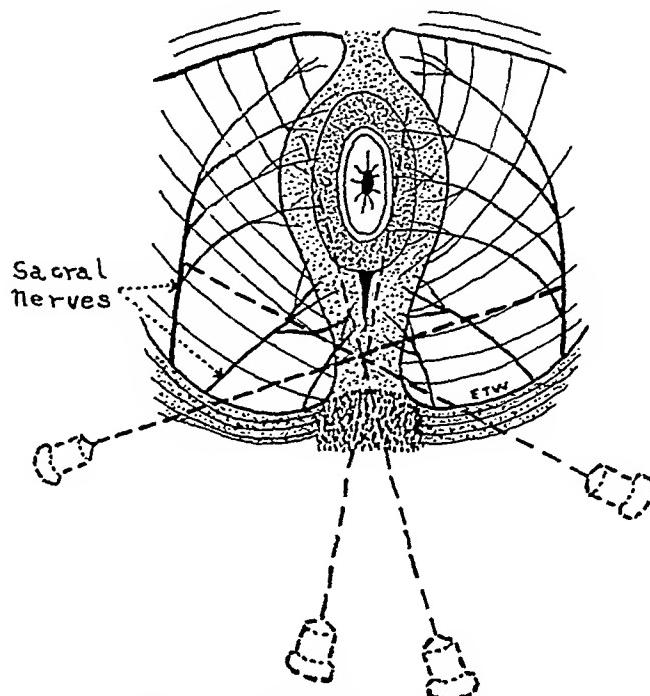


FIG. 5. A diagram illustrating the technic of introducing the oil anesthesia. Through one needle hole in the posterior commissure, the sphincters on each side of the anus, the sacral nerve supplies on each side and the levator-ani in the region of the posterior commissure, can be injected. However, to some it might be easier to inject all of these areas through two needle holes, each to one side of the posterior mid line. This blocking of the sacral nerves with a long lasting anesthetic has encouraging possibilities and calls for further investigation.

proximately 58 per cent of all patients with rectal complaints have hemorrhoids and that at least a quarter of the latter require operation.

#### TAKING THE PAIN OUT OF HEMORRHOIDECTOMY

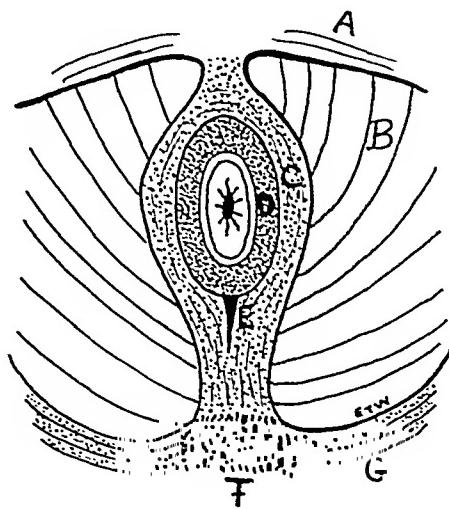
In cases in which a hemorrhoidectomy is necessary, the patient accepts it more readily if he can be assured that it will not require etherization, that postoperative pain has been practically eliminated, that the stay in the hospital is at least one-half what it was twenty years ago and that absence from work will probably not be longer than two weeks. However, there is no miracle in this removal of pain, dis-

sible, of using accepted improvements in technic and of paying attention to details. The following is a list of the more progressive and useful measures in the order of their importance: (1) A posterior sphincterotomy or "pectenotomy"; (2) use of oil anesthesia; (3) all sutures above area of sensation; (4) clean cut, systematic surgery; (5) successful pre- and intra-operative narcosis; (6) regional, spinal and caudal anesthesia; (7) intelligent post-operative dressings; (8) prevention of complications, and (9) management of the postoperative stool.

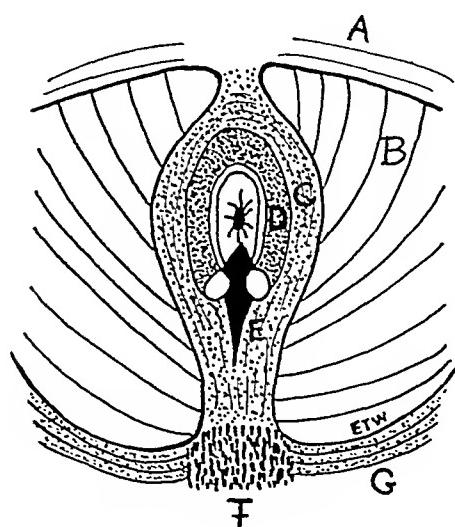
*Posterior Sphincterotomy.* One of the most important, recent advances in proctology is the posterior sphincterotomy and

our experience has proved it to be a very necessary addition to a hemorrhoidectomy. As the literature covering this operation

portion of the external sphincter at the latter location, each stroke being guided by the left index finger. (Fig. 7.) The



Intact Perianal Musculature.



Posterior Sphincterotomy.

FIG. 6. Diagrams illustrating what is severed as the result of a posterior sphincterotomy. A, the perineal muscles; B, the levator ani; C, the superficial and deep portions of the external sphincter; D, the subcutaneous portion of the external sphincter; E, Minor's triangle or the posterior triangular space; F, the coccyx; G, the glutei. The posterior sphincterotomy simply incises the subcutaneous portion of the external sphincter (D) and also further separates, somewhat, the two legs of the superficial portion of the external sphincter (C) as they go off at a tangent to form Minor's triangle (E) and become attached to the coccyx (F).

is not extensive, we will describe it in some detail.

The most superficial portion of the external sphincter, called the subcutaneous sphincter ani, is that portion which is felt first by the finger upon entering the anus. It is this muscle which goes into spasm following infection or trauma in this region. Previously, this spasm was overcome by so dilating or stretching the muscle that it became paralyzed temporarily but today such a result is more effectively and safely obtained by means of incising it either at the posterior commissure (Figs. 6, 7 and 8) or in one of the anterolateral quadrants. We prefer the former location.

The left index finger is introduced into the anus up to the level of the intersphincteric septum which is that depression existing between the internal and the external sphincters but detected best in the region of the posterior commissure. The scalpel then incises, by successive strokes, the skin and this subcutaneous

internal sphincter and the major portion of the external sphincter are in no way affected as the incision is carried down only to the distal tip of the internal sphincter and passes backward between the two tangential legs of the superficial portion of the external sphincter. (Fig. 6.) Following incision of the muscle, the overlying skin edges are cut back somewhat on each side in order to prevent too rapid reapposition. The severed muscle unites again within a week or ten days and re-epithelialization takes place in from two to six weeks depending upon the amount of skin removed, the depth of the incision and healing powers of the patient. Sometimes cavitamic acid is needed.

We cannot emphasize too strongly the advantages of such a posterior sphincterotomy in a hemorrhoidectomy. It may be done as a first step whenever exposure is difficult to obtain, as obtains in some cases in which the anus is abnormally long and the internal hemorrhoids are far up inside.

But it should always be done either prior to or after the hemorrhoidectomy for the following reasons: It prevents the onset

premature formation of such a band following the hemorrhoidectomy.

*Oil Anesthesia.* Another important re-

FIG. 7.



FIG. 8.



FIG. 9.



FIG. 10.



FIG. 7. Doing a posterior sphincterotomy.

FIG. 8. Finish of the posterior sphincterotomy.

FIG. 9. Before operation.

FIG. 10. Three weeks after operation.

of any postoperative spasm as mentioned above; it prevents edema from forming in the strips of anal skin left between the excised hemorrhoids (Fig. 10); it opens up the anus so that a pressure dressing can be applied and maintained where needed most, thereby eliminating the necessity for intra-anal drains, packs, "whistle tubes," etc.; and finally it quite definitely prevents stricture formation in two ways: first, by so laying the anus open that no false apposition occurs across from one raw area to another prior to epithelialization, and second, it severs any pre-existing fibrous pecten band<sup>9,10</sup> and prevents the

cent advance in proctology is the use of a local anesthetic in oil. When this was first introduced by Gabriel<sup>11</sup> it was greeted with much approval but soon fell into disfavor following the occurrence of sloughs and abscesses. However, the current solutions now in use and their proper employment have been so perfected that the latter are rarities. Personally, we have used between 400 and 500 ampules of a certain oil anesthetic\* with only one complication, an abscess out in the buttock which more probably was caused by infection carried there by the needle. We are certain that

\* Prococaine. Columbus Pharmacal Company.

the use of such an anesthetic not only enhances the regional and block anesthesia and the sphincter relaxation during the operation but it also definitely reduces postoperative pain, discomfort, tension and difficulty with bowel movements for at least five days. But to obtain these benefits and to avoid complications, the proper technic of injection is required. The syringe used should be a dry one, the needle a No. 19 gauge, and the site of injection should be resterilized. Only one or two needle holes are necessary about an inch behind the anus. One cc. of oil is injected, from this location into each of five different places: into the sphincters on both sides of the anus, into the sphincters and levator ani behind the anus and out into both buttocks as described later in the description for injecting novocaine. (Fig. 5.) No oil is placed superficially beneath the skin. After withdrawal of the needle, the whole area is massaged well to prevent unavoidable pooling. In many patients an onset of symptoms occurs five or six days postoperatively which is an indication that the oil anesthesia had been operating previously. These patients should be given codeine for a day or two.

*Place Sutures in Non-sensitire Area.* A suture producing tension within the area of sensation at the anus is a constant source of pain for several days, especially upon motion of the gluteal and back muscles. Therefore, the dissection of the external hemorrhoid should be carried up to and beyond the mucocutaneous (pectinate) line so that the suture transfixing the pedicle will be above any area of sensation. Active bleeders should be transfixed, of course, but such transfixations do not seem to have the same disabling effect as do pedicles clamped and tied too low. In the usual hemorrhoidectomy technic, the closure of the anus brings the skin edges together as much as is desired so that any stay or approximating sutures are unnecessary. If the Bacon method<sup>17</sup> is used, it will be seen that the approximating sutures place no tension on the skin edges.

*Clean-cut Surgery.* By clean cut surgery, we mean the careful excision of all so-called cowls, skin tabs, tits of skin, etc., on the edges of the incision as they have a tendency to become edematous and later persist in the form of skin tabs. This applies to any and all methods of performing a hemorrhoidectomy. We herewith present no preference for any one technic other than that it be simple, allow plenty of drainage and produce no tension on the anal skin.

*Preoperative Narcosis.* The secret of a successful preoperative narcosis is the use of small doses of several synergistic drugs at the proper time. There are many variations but the following is an example which has most patients nearly asleep on arrival at the operating room and in slumber by the time the local anesthesia has been injected:

Dilauidid gr.  $\frac{1}{32}$  or morphine gr.  $\frac{1}{6}$  and Scopolamine gr.  $\frac{1}{150}-\frac{1}{200}$  s.c. 1 hour before operation

Seconal or nembutal gr.  $1\frac{1}{2}$  p.o.  $\frac{1}{2}$  hour before operation

We like dilauidid because it seems to cause less postoperative nausea than does morphine. The proper timing is important as has been made plain by Leigh.<sup>12</sup> The opiates seem to require at least an hour to produce their analgesic effects while the short acting barbiturates require only one-half an hour. In our experience, one-half the dosage of all these drugs should be given to those over sixty, to the frail and debilitated and to those having had cardiac decompensation.

*Anesthesia.* One of the authors (G. A.) prefers spinal anesthesia. This can be given in a small dose to produce only a "saddle" area of anesthesia. It gives excellent relaxation and exposure. Hirschman<sup>13</sup> recommends a caudal anesthesia but we have found the waiting period, before the novocaine "takes," to be irritating. However, the same results can be had with regional and block anesthesia if the proper technic is used. (E. T. W.) From 30 to 50 cc. of 2 per cent novocaine with adrenalin is

required. We have had no one "feel" the adrenalin and its inclusion is very necessary to prevent any allergic or toxic reaction from too rapid absorption of the novocaine. We wish to repeat this admonition: Never inject novocaine, without adrenalin in it, into the tissues about the anus as the blood supply is so great that it can be taken up too quickly. The injection must be made systematically—*under* the peri-anal skin, *into* the sphincters and out *into* the buttocks. A three-inch needle (No. 20 gauge) is quickly inserted through the skin about an inch behind the anus in the posterior commissure and from this one position 10 to 20 cc. of novocaine are injected *beneath* the peri-anal skin nearly all the way around the anus. A little may have to be injected anteriorly through other needle holes. Injecting *beneath* the skin does not abolish the landmarks. Secondly, 5 to 10 cc. are injected into the sphincters lateral to the anus first on one side of the anus and then on the other side (Fig. 5) and also deeply into the sphincters and the levator ani behind the anus. Finally, 5 to 10 cc. are fanned out into each buttock to anesthetize the sacral nerves which emerge from beneath the gluteal muscles, thereby producing a block anesthesia. (Fig. 5.) The left index finger in the rectum guides the introduction of the needle into these various locations.

*Postoperative Dressings.* The postoperative dressings are necessary only to prevent oozing as all major bleeding points are supposedly tied off as mentioned in a preceding paragraph. The posterior sphincterotomy allows pressure by means of dressings to be applied right up to the internal sphincter and in many cases even up to the location of the ligated pedicles. This pressure is held in place by adhesive, not by a T binder. No rubber drains of any kind are needed.

*Prevention of Complications.* The complications of a hemorrhoidectomy include postoperative bleeding, urinary retention, infection and stricture. Postoperative

bleeding can be controlled by adequate care of bleeding points and transfixations during operation and by giving an ampule of vitamin K routinely prior to operation in order to overcome any decrease of thrombin production caused by the administration of the barbiturates.<sup>14</sup>

The problem of postoperative catheterization is a serious one in rectal work. The nervous inter-relationship between the anus and the urinary bladder causes pain and spasm of the anus to throw the urinary sphincter into spasm and paralyzes the detrusor muscle. Theoretically, the better the sacral nerves in the buttock are anesthetized by oil anesthesia, the less the urinary nervous system will be disturbed and, of course, all of our pain and spasm preventing measures help. Nevertheless, retention still occurs. However, we have had considerable success in reducing this by using an ampule of doryl<sup>15</sup> prior to catheterization. Woodruff et al.<sup>16</sup> have suggested instilling an ounce of 0.5 per cent aqueous mercurochrome into the bladder at the time of operation to stimulate the detrusor muscle. We have used this routinely in all of our recent cases done under spinal anesthesia with a definite decrease in the need of catheterization. However, in our cases in which local anesthesia is used, mercurochrome is not instilled at the time of operation because catheterization at that time is as bad as it is eight hours later. However, when the latter is necessary we promptly start a urinary antiseptic.

As the result of leaving the wounds open and as the result of the early institution of the hot sitz bath (second day after operation) we see practically no infection. Stricture is prevented in three ways: (1) by care during the operation to leave two or three parallel strips of skin and mucous membrane running up from the peri-anum into the rectum; (2) by the use of the posterior sphincterotomy and, (3) by frequent postoperative digital examinations and the breaking down of false appositions.

*Postoperative Stool.* The postoperative stool is had forty-eight hours after operation by means of an oil retention enema followed in an hour by a saline enema (followed by a hot sitz bath). Mineral oil ( $\frac{1}{2}$  ounce nightly) is started even before operation and continued until healing is had. This much oil will not leak and does soften the stool.

#### MEASURING PROGRESS

Progress in the management of the hemorrhoidectomy can be gauged by examination

TABLE II\*

DAYS OF HOSPITALIZATION OF NINETY-SIX CAMBRIDGE HOSPITAL SERVICE HEMORRHOIDECTOMIES DURING THE YEARS 1921-1942 AS COMPARED WITH FORTY-FIVE SERVICE CASES HANDLED AS OUTLINED IN THE TEXT

Cambridge Hospital Service		Our Service	
1921-1925, 30 cases	1926-1935, 36 cases	1936-1942, 30 cases	1941-1942, 45 cases
10.7	8.3	7.7	4.4

\* If we may cite the above figures as a criterion, the ordinary hospital service hemorrhoidectomy was requiring, roughly, an average of eleven days' hospitalization some twenty years ago and less than eight days now. As a result of the various measures outlined in the text, our service cases are confined an average of less than five days.

tion of Table II which shows how the length of stay in the Cambridge Hospital of ordinary service hemorrhoidectomies has decreased during the past twenty years from 10.7 days in the early 1920's to 7.7 days in the early 1940's. However, when the preventive measures, which we have outlined, are consistently applied, as has been done in our service cases during 1941 to 1942, the length of the hospital stay has been reduced to 4.4 days which is nearly one-half that of the cases at the Cambridge Hospital.

#### SUMMARY

Much progress has been made in the treatment of hemorrhoids during the past few years and, yet, there is still a surprising

amount of confusion with reference to the subject among the medical profession.

A review is made of the anatomy, physiology and pathological conditions of the anus and their effect on the genesis of the various types of hemorrhoids.

Selection of the proper form of therapy is discussed. Simple, internal hemorrhoids are injected; frank double hemorrhoids are excised.

A review of 1,056 consecutive rectal cases admitted to the Boston Dispensary and the Cambridge Hospital was made in order to ascertain the percentage having double hemorrhoids and therefore needing operation. Of the 1,056 patients, 615 or 58 per cent had hemorrhoids in one form or another. Of the 615 hemorrhoids, 161 were of the double variety. This is 26 per cent of the total number of hemorrhoids or 15 per cent of the total number of 1,056 patients with rectal complaints. It is concluded, therefore, that approximately 58 per cent of all patients with rectal complaints have hemorrhoids and that at least a quarter of the latter require operation.

When a hemorrhoidectomy is indicated, the layman accepts it more readily when he can be assured that the dreaded post-operative pain, discomfort and disability of the past has been practically eliminated. The latter has been accomplished, not as the result of some new operation, but mainly as the result of using those advances made recently in proctology which are applicable to a hemorrhoidectomy. These are to be found both in the field of technic and in our newer knowledge of the anatomy of the anus. They include the posterior sphincterotomy, the use of an oil anesthesia, careful surgery with the main transfixing sutures above the area of sensation, prevention of postoperative complications and intelligent management of the first stool.

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**Correction:** In the article, "Carcinoma of the Tip of the Tongue," by Dr. Fink and Dr. Garb, which appeared in our October 1943 issue, the authors wish to draw the readers' attention to an error they made on page 141. The sentence, "Ochsner and DeBakey reported a series of 3,047 collected cases of primary carcinoma of the tongue . . ." should have read, "3,047 collected cases of primary carcinoma of the lung."

# PREOPERATIVE AND POSTOPERATIVE TREATMENT OF THE TOXIC THYROID\*

FREDERIC E. SANFORD, M.D.†

WILLIAMSPORT, PENNSYLVANIA

THE preoperative and postoperative treatment of the toxic thyroid patient which includes hyperthyroidism, both primary and secondary, Grave's disease, exophthalmic goiter, toxic diffuse goiter and toxic nodular goiter, is a fascinating subject. Its historical development dates back many centuries probably as early as 1000 A.D. In 1170, Roger, at the University of Salerno, Italy, prescribed ashes of sponge and seaweed for goiter, however, the first operation was performed about the year 1000. Writing in 1271, Marco Polo said of the inhabitants of one of the countries he visited: "They are in general afflicted with tumors in the throat occasioned by the nature of the water which they drink." All through the centuries, until the present time, the treatment has varied considerably, and the story of its development is of great interest. The contributions of Kocher, C. H. Mayo, Plummer, Crile and Marine, who were pioneers in the study of the thyroid, are responsible for our present knowledge of the subject. A short résumé of the history will not only be entertaining and enlightening concerning the development and treatment of the condition but also reveal that much may yet be learned about this important subject.

## HISTORY

According to Hegner,<sup>1</sup> the early treatment of goiter filled many pages, from transfixing with shoe laces and permitting the ligated masses to slough—this being practiced by Roger Trugardi in 1170—to the cure by the King's touch which was practiced from 1100 to 1600. Andre Du-laurens claimed that his King, Heindriche

iv, cured about 1,500 persons annually. A western Arabian of Cordova, Spain, by the name of Albucasis, is credited to be the first to operate for goiter. This was done as stated about the year 1000. Various attempts were made at thyroid surgery throughout the intervening years and Hedenus of Dresden, in 1821, recorded six successful operations for extensive thyroid disease. His record was not excelled for almost seventy years. Kocher studied the gland from an anatomical standpoint and did much for thyroid surgery. In 1874, he did his first total extirpation on a girl eleven years of age. A few weeks later she developed marked changes in character, became dull, sluggish and sullen. After Reverdin reported, in 1882, on two cases of myxoedema ex-extirpatione gland thyroideae, Kocher examined 101 of his cases and took a decided stand against extirpation and it was many years before he performed a bilateral resection.

The description of hyperthyroidism or exophthalmic goiter by Parry (1787), Grave (1835), and Basedow (1840), and of hypothyroidism or myxoedema by Curley (1850), Gull (1875), and Ord (1877) emphasized the mysterious importance of the thyroid gland. Moritz Schiff, a Geneva physiologist, in 1856-1884, made his experiments on the effects of the excision of thyroid in dogs, the prevention of these effects by thyroid grafts and by injection or ingestion of thyroid juices. Because of these experiments he is considered a pioneer of the doctrine of internal secretion and a prophet of thyroid therapy. Coindet, in 1820, was the first to show that iodine was of value in thyroid disorders and in 1850,

\* From the Guthrie Clinic, Robert Packer Hospital, Sayre, Pennsylvania. † Dr. Sanford is now a Lieut. Colonel in the Medical Corps of the U. S. Army.

Chatin presented evidence that iodine would prevent endemic goiter. In 1868, Trausseau gave tincture of iodine instead of tincture of digitalis to a patient with exophthalmic goiter by mistake. All toxic symptoms promptly subsided but he thought this was an exception rather than the rule and cautioned against its use in Graves' disease. Eugene Gley, of Evipal, professor of physiology in the Paris faculty, in 1889, demonstrated the existence of iodine in the thyroid gland and the blood. Kocher, in 1904 and 1911, noticed untoward effects in the use of iodine and advised against its use and, because of his wide influence, the drug fell into disrepute. Plummer is given the credit in America for calling attention to iodine in the treatment of exophthalmic goiter.

#### PHYSIOLOGY AND CHEMISTRY

To understand the physiology and chemistry is almost essential to treat the condition scientifically. Marine<sup>2</sup> has done much to clarify this, but there still remains many gaps which require further research. Possibly in ten more years a part of the present information will be discarded as obsolete. The greatest advances in the last decade have been in the chemistry of thyroxin and the interrelationship of the thyroid with other organs of internal and external secretion. Ancestrally speaking, the thyroid belongs to the alimentary tract. Its functional activity may be increased or decreased with tremendous capacities as indicated by changes in weight, microscopic appearances, iodine content and blood supply. It has been demonstrated that hyperplasia of the gland indicates hyperactivity but not necessarily hyperfunction. Its chief roll in metabolic physiology is to increase the oxidative processes in the body. The normal human gland weighs from 20 to 25 Gm. and its maximum iodine store is from 20 to 25 mg. (the average normal being 10 to 15 mg.). An interesting factor is that there is a seasonal variation in the iodine storage which is lower in early spring and higher

in the late summer. The fetal thyroid readily stores iodine given to pregnant mothers. It is the only organ capable of elaborating the iodine containing hormone; however, iodine is present in the anterior pituitary and in the ovary in significant amounts, but owing to the close relationship now known to exist between these three glands its presence could be of thyroïdal origin.

Thyroxin ( $C_{15}H_{11}O_4NI_4$ ) or tetraiodothyronine, was extracted by Kendall in 1916. The mother substance of thyroxin is L-tyrosine. Thyroxin appears to be only the active chemical group of the true hormone which is probably iodothyroglobulin. According to Oswald, there are slight but definite pharmacological differences between thyroxin and iodothyroglobulin. Harrington has estimated that, on an average, 40 per cent of known thyroïdine is in the form of thyroxin and 60 per cent as di-iodotyrosine. Di-iodotyrosine is a stage in the synthesis of thyroxin in the thyroid. This synthesis of thyroxin requires hours while the storage of iodine is almost instantaneous. The form in which iodine is stored is not known. The most characteristic physiological effects of iodothyroglobulin or its active chemical group thyroxin is, that it increases, after a latent period of two hours or more, the oxidation in the body of proteins, fats and carbohydrates and that it also increases the excretion of certain minerals notably calcium and magnesium. The means by which thyroxin increases the metabolism in the cells is unknown. The relation of thyroid to antibody immunity shows no direct association, however, the lowering of iodine store and the tendency to thyroid hypertrophy in many infectious diseases indicates that the thyroid is an important indirect factor in resistance of infections. A diet rich in proteins and fats increases the rate of discharge of thyroxin, and thyroid activity is more necessary in the oxidation of fats and proteins than for carbohydrates. The experiments of Bauman and Hunt demonstrated that thyroid secre-

tion was necessary for the specific dynamic action of foods.

In discussing the relationship of the thyroid to the pituitary gland one notices that the anterior pituitary gland is the master gland and controls the functional state of the thyroid, sex glands, adrenals, and other organs. Since the thyroid enlarges during menstruation, pregnancy and the increased frequency of goiter during puberty, pregnancy and the menopause, it shows that there is a definite thyroid-sex gland relationship. The thymus involutes more rapidly after thyroidectomy, therefore, it must play a factor in the control of this gland. Bodansky believed that the thyroid hormone promotes glycogenolysis and that it is because of this action the hypoglycemic action of insulin is increased after thyroidectomy and decreased by thyroid feeding. This gives its pancreatic relationship. Experimentally, it has been confirmed that prolonged thyroid feeding greatly reduces the glycogen store in the liver. The thyroid hormone also increases the irritability of the sympathetic nervous system, or sensitizes in some way the tissues innervated by it so that they are more susceptible to stimulation by epinephrine. The adrenal cortex and sex glands acting through the anterior pituitary normally exercises some regulatory or inhibitory control over thyroid function. When this control is sufficiently depressed or withdrawn the activity of the thyroid is temporarily increased. Improved water elimination in certain forms of nephritis by the administration of dessicated thyroid, and more recently thyroxin alone or combined with parathyroid extract, shows its kidney relationship. It is used particularly in lipoid nephrosis. There is no explanation except the possibility that these drugs increase the mobilization and excretion of calcium.

The sequence of events as Bard<sup>3</sup> stated them from his recent review of the literature, is that "the fundamental biological significance of the gland seems to lie in its function of aiding the organism in adapta-

tion to changing environment—external and internal such as climacteric alterations, dietary changes and such epochs of special stress a puberty and pregnancy."

#### CLASSIFICATION

In order to clarify the subject of goiter, the Committee on Classification of the American Association for the study of Goiter has recommended a clinical classification. This classification has received widespread adoption by the profession and is as follows:

*A. Non-toxic Diffuse Goiter.* This includes the adolescent goiter and colloid goiter. Its treatment consists mainly of prophylactic iodine twice a year and at times thyroid extract or thyroxin alone with the iodine. Surgery is rarely indicated in this type except for cosmetic purposes.

*B. Diffuse Toxic Goiter.* This type of goiter appears ten years earlier than the nodular group. It includes the so-called exophthalmic goiter, Basedow's disease or Graves' disease. Its etiology is unknown. It is not endemic and is associated with the full grown picture of hyperthyroidism. The treatment for this type is surgery.

*C. Nodular Toxic Goiter.* This is the type that usually shows extensive cardiac damage. In many cases they are poor operative risks yet surgery is the method of choice for treatment.

The treatment as set forth in this paper has to do with the diffuse toxic and nodular toxic types which need much study and preparation before surgery can be safely attempted.

#### SYMPTOMATOLOGY

The symptomatology of the toxic thyroid may be roughly divided into primary and secondary hyperthyroidism. The primary hyperthyroid cases are those which include the exophthalmic goiter, and occurs usually early in the third decade. The onset is sudden. These patients may show signs of exophthalmos and have a definite stare, however, this is not always a true sign. Hyperirritability, emotional instability, in-

creased heat elimination, nervousness, purposeless movements, tremor of the hands, weight loss with increased appetite, shortness of breath, palpitation and tachycardia are the cardinal symptoms. If a patient early in the third decade of life shows these cardinal symptoms, one can be almost sure that they are dealing with a case of primary hyperthyroidism. The development of eye changes and the tendency for the unrecognized and untreated goiters to develop gastric crises, coma and death differentiate primary hyperthyroidism from the secondary hyperthyroidism due to adenoma.

Secondary hyperthyroidism which includes toxic adenomas has a more insidious onset; 60 per cent of patients are over sixty years of age. There is also evidence of definite cardiac damage with cardiac enlargement, shortness of breath, palpitation and tachycardia. They, too, have an increased heat elimination, weight loss, nervousness, tremor and definite fatigue. Any patient falling into any one of these two groups should be given thorough study because surgery will undoubtedly be the method of choice in treating these unfortunate individuals. Many mistakes have been made in confusing this condition with heart disease, hypertension, neurosis, pulmonary tuberculosis, acute abdominal states and certain apathetic conditions.

The various methods in common use today to determine the extent of toxicity and also the degree of damage done by this toxicity are definite guides in the preoperative treatment. These tests include fourth hour temperature and pulse readings, complete blood count, blood cholesterol, urea nitrogen and sugar determinations, complete urinalysis, electrocardiogram, roentgenography, laryngoscopic examinations, blood pressure, frequent weight readings, basal metabolism rates, compliment fixation tests for syphilis and other less frequently used tests such as the hippuric acid test for liver damage. A correct analysis of the data obtained by these foregoing tests together with the therapeutic use of iodine

and daily observations of the patient decide whether or not the patient is one who requires surgery and one who will be a safe operative risk.

To be able to diagnose a condition is probably the most important phase of medicine but often times the literature is much too voluminous in the clinical aspects of the disease and too little is said of treatment, at least proper treatment. This is true of the toxic thyroid.

#### PREOPERATIVE TREATMENT

The proper care of the toxic thyroid must begin with the general practitioner who usually first sees the patient. He must be on the alert because many of the patients show very little signs and symptoms. When he has made the diagnosis he must be frank with the patient concerning the proper course to take for future treatment. He should not be an alarmist but must be firm enough to convince the individual that the advice of a specialist must be obtained. No preliminary medication should be given except possibly mild sedatives and advice about proper diet and rest nor should any medication containing iodine be given. The physician's next step should be to select a good surgeon, one who is considerate and one who operates in the most pleasant surroundings. This is discussed thoroughly with the patient and this discussion should be such that the individual will have a feeling of confidence before he has been definitely referred to a clinic for future study. An early appointment should then be made so that the patient does not have time to fret and worry. A personal letter of introduction often helps because the patient will feel that there is something in common between the referring physician and the specialist group.

Conklin<sup>4</sup> claims that to carry out successfully a program which gives the patient psychic support and keeps emotional upsets at a minimum in the preoperative care, it is highly desirable that this preparation be confined to a small group of

experienced men who have charge of all patients with this disease. He believes also that the preoperative preparation of the goiter patient can best be directed by a small group of men with the co-operation of the surgeon in charge of the case. The close co-operation of an experienced internist with the surgeon in the original examination of the patient, in the diagnosis and evaluation of the degree of hyperthyroidism, during the preoperative regimen and in making the decision as to when surgery can most safely be performed is most desirable, in fact, the internist can usually spend more time in the direction of the details of the goiter patient's preparation and thus is better fitted than the surgeon to have major charge of the preoperative management.

Even though a complete history is imperative, the original history may be only cursory and can be completed at subsequent visits so that the patient is not unduly tired or excited by this or a thorough physical examination. The history should include the age at which the patient first noted the goiter, and the elucidation of the symptoms of toxicity and their duration is also important. Weight loss in spite of a good appetite is also important to elicit. One must also determine whether or not iodine has been taken, how much and over how long a period of time this medication was given. If the patient has improved under iodine therapy, it is important evidence of the toxicity of the gland. Reassurance is a prime essential in the goiter patient and at the original examination the patient should be given encouragement, assured as to the ultimate outcome and told just what studies are to be carried out and the reasons for these studies. Conklin<sup>4</sup> also states that this résumé of the coming examination will aid greatly in obtaining the maximum co-operation and the minimum psychic upset caused by encounters with unfamiliar procedures. The patient is carefully admitted without delay. As soon as the patient is comfortably situated no

more is done that day. The routine orders, such as complete blood count, urinalysis and fixation tests, are ordered for the following morning. If the patient is not too nervous, the breakfast is delayed and a basal metabolic rate determined. This should be spoken of as the "breathing test" and the details of the procedure outlined so that it will not alarm the patient. This may be delayed until the second morning when possibly a more accurate test can be obtained because the first night in the hospital may be a restless one, thereby giving an untrue reading. The metabolic rate should be repeated the following day. The usual house diet is ordered for the first few days. A fasting blood sugar, also a blood urea nitrogen and blood cholesterol determination are made in the first few days. After the basal rates are obtained, such examinations as the routine larynx examination is made by the laryngologist who also makes sure no upper respiratory infection is present. Because of the danger of injuring the recurrent laryngeal nerve causing vocal cord paralysis, it is always advisable to know whether or not the vocal cords are in good condition before operation. If a substernal thyroid is suspected, a roentgenogram is made to determine the extent. It is wise in most cases to have the cardiologist examine the heart muscle and take an electrocardiogram but this is not necessary in every case. Any other laboratory tests that are necessary are made at this time. From this information the patient is put on a fairly strict routine that must be carried out from day to day.

Iodine plays the most important rôle in preoperative therapy. Under no circumstances should it be given unless operation is anticipated or agreed upon because of the false security it may give the patient and deleterious effects it may have upon the gland itself. Marine and Plummer are responsible for establishing order where chaos previously prevailed with regard to the successful cure of hyperthyroidism. In 1912, Marine<sup>6</sup> claimed that the use of

iodine would temporarily cause a reversion of the hyperplastic gland to the colloid state and with it a short respite in the toxic symptoms. During this time surgery could be done with comparative safety.

Remington<sup>7</sup> stated that the normal thyroid gland contains about 10 mg. of iodine at a concentration of 40 mg. per cent by weight. This is found principally in the colloid, according to Van Dyke.<sup>8</sup> The normal iodine content of human blood is about 12 micrograms per cent; this means that the normal blood contains about 120 parts of iodine per billion. Curtis<sup>9</sup> has shown that the blood iodine as a rule is increased in patients with hyperthyroidism, however, about 10 per cent of the determinations may fall within the higher normal range. The average increase to 27 micrograms per cent is greater in patients with diffuse hyperplastic goiters, with or without exophthalmos, than with toxic nodular goiters, the average in the latter being 22 micrograms per cent. The increase is accentuated by menstruation and pregnancy.

Kolnitz and Remington<sup>10</sup> have shown that there is a correlation between the season of the year and the weight and total iodine content of the thyroid. The summer glands are both heavier and richer in iodine but the percentage of iodine remains practically constant.

After iodinization with Lugol's solution or any form of iodine thus far investigated there ensues a sharp increase in the hyper-iodenia (Curtis).<sup>9</sup> This increase is principally in the organic fraction and is due to the medication, while there is a decrease in the alcoholic insoluble organic fraction. Thus the circulating thyroid hormone is presumably lessened. Iodine and thyroid function are inseparably related since the thyroid is the principal storehouse of iodine.

Curtis and Poppel<sup>11</sup> have shown that the utilization of iodine to form thyroid hormone is thus an integral part of the thyroid activity. As a consequence the metabolism of iodine becomes of funda-

mental significance in the investigation of thyroid physiology and of the changes in function incident to the development of thyroid disease. The above authors also bring out four features of metabolism of iodine in exophthalmic goiter: first, the thyroid gland iodine is decreased in untreated cases; second, the blood iodine is usually increased in untreated cases; third, the urinary secretion of iodine is usually increased; and fourth, exophthalmic goiter presents an increased negative iodine balance. Patients with toxic nodular goiter present an even greater negative iodine balance due to a greater urinary excretion. Nevertheless, the excretion of iodine in the feces and sweat is greater in exophthalmic goiter.

Immediately following thyroidectomy, a rise in the blood iodine of non-iodinized patients occurs. There is usually a fall in the level following thyroidectomy on patients treated with Lugol's solution or some iodine preparation. The blood iodine then remains irregularly increased as long as postoperative iodine is continued. Subsequent to an adequate thyroidectomy for hyperthyroidism and the cessation of post-operative iodine, the blood iodine eventually decreases to a low normal level. This blood iodine relationship of exophthalmic goiter is similar to that of toxic nodular goiter. Two evidences then of iodine deficiency are thus demonstrated in patients with hyperthyroidism, first, the decreased iodine content of the thyroid gland, and, second, the increased loss of iodine in the urine. Further evidence of the deficiency is shown by the usual response to iodinization which is really a form of replacement therapy. Means and Lerman<sup>12</sup> stated that the clinical facts regarding iodine in thyrotoxicosis is that, it produced an altogether characteristic and specific response which consists of an amelioration of symptoms and a drop in metabolic rate. This response will occur at any stage of the disease. It also appeared that the response had no relation to the duration or direction of progress of the disease but

merely acted as a check on the intensity of its symptoms.

These clinical facts are consistent with the theory that in the toxic thyroid, the thyroid allows the escape of thyroxin to precede at an excessive rate and the cells of the gland hyperfunction in consequence. It is suggested then that iodine sets up a temporary barrier to this excessive outflow and checks the leakage of thyroxin from the gland. The known facts of iodine and thyroxin content of the blood, urine and gland bear out this theory. Means and Lerman<sup>12</sup> also believe that refractiveness to iodine is apparent and not real and that, if the truth be known, those patients in whom iodine has no effect are already iodinized. Curtis<sup>9</sup> also stated that by investigating this iodine metabolism it is becoming possible to leave the earlier empiricism and to adopt a more scientific technic of the use of iodine in both the treatment and prevention of thyrotoxicosis.

The form in which iodine is used is of no particular importance because it is active in any form provided the minimum effective dose or more is given. Plummer<sup>13</sup> introduced iodine in the form of Lugol's solution in 1922 and this is probably the most commonly used preparation today. The average dose is minimis 5 to 20 (.3 cc. to 1.2 cc.) three times a day and Guthrie and Conklin<sup>14</sup> use from 10 to 15 minimis (.6 cc. to 1 cc.) according to the toxicity of the case at hand. The response to ethyl iodide and potassium iodide is essentially the same as that of Lugol's solution. The potassium iodide is given in a saturated solution, 10 minimis (.6 cc.) three times daily. Iodine may be given by mouth, rectum or vein and is equally effective in all three routes. Jones<sup>15</sup> recommended intravenous iodine in the form of sodium iodide because it can be pushed faster in cases of thyroid storm and in those cases showing gastrointestinal symptoms which would be aggravated with the drug by mouth.

Wetherell and Groat<sup>16</sup> advised that when iodine is administered over long periods of

time, its administration should be interrupted for a week or ten days every four to six weeks.

When iodine is intensively administered to a patient with hyperthyroidism, previously untreated with iodine, a marked clinical remission in the course of the disease is noted in seven to ten days and usually continues for two or three weeks. It is during this clinical remission that operation should be performed, because it has been definitely demonstrated that the mortality rate has been reduced to practically nil if surgery is done at this time. Poste<sup>17</sup> claimed that there are three things to watch for when giving iodine: first the slowing of the pulse rate; second, the amelioration of symptoms; and third, the hardening of the thyroid. If these three things occurred there will undoubtedly be a drop in the basal metabolic rate and the operation will be safe.

Goetsch<sup>18</sup> stated that if operation is not done during this remission, the patient often relapses into a state of clinical exacerbation in the course of one, two or three months and a condition of uncontrollable hyperthyroidism may result. Spontaneous hyperthyroid crisis which occurs occasionally in the course of the disease may be controlled by large doses of iodine, but when a crisis occurs as a result of the incorrect use of iodine, the further administration of iodine, even in greater amounts, is ineffectual and the patient may die.

Many individuals take iodine without the advice of the physician and because of this Guthrie<sup>19</sup> stated: "The public should be warned of the great danger in the self administration of iodine for the treatment of goiter, and physicians should have a clear understanding of the types of goiter that are amenable to the iodine treatment and of the danger which attends its incorrect use."

A false impression may be obtained in stating the number of days required to prepare a patient properly, however, in a series of 100 cases selected from the files

of the Guthrie Clinic during the years 1938 and 1939, eleven days was the average. A few patients were ready in less time and a large number required as long as two to three weeks. This clinic has spent as long as seven or eight weeks to make the patient safe for operation, therefore, no definite time limit should be set. The subject of rest should be thoroughly outlined for the aged, those with severe toxicity and those showing cardiac decompensation. The patient is awakened about 7 A.M. and breakfast is served. The patient should then stay in bed until about 10 A.M., when he is allowed out of bed for about one hour. This gives plenty of time to rest awhile before having dinner. The afternoon is broken up by allowing activity for two hours sometime in the mid-afternoon. The patient is again put to bed for rest before the evening meal and made to stay for the balance of the evening until time to retire. This should not be later than 9 P.M. A large number of patients, who do not show cardiac decompensation, and are younger and have a mild or moderate degree of toxicity, are allowed to be up and about as they desire. This added freedom seems to benefit them more than the bed rest routine. If sleep is difficult, a mild sedative, such as, sodium bromide gr. 15 (.1 gm.), phenobarbital gr. 1½ (.13 gm.), seconal gr. 1½ (.13 gm.), amytal gr. 1½ (.13 gm.), or nembutal gr. 1½ (.13 gm.) may be used. In more severe cases morphine sulfate gr. ½ (.011 gm.) may have to be given at bed time, however, this should not be carried out over a long period of time because of the danger of addiction. If the patient shows extreme restlessness during the day, a mild sedative, such as elixir of phenobarbital drachms 1, (4 cc.) three or four times during the day, may be helpful. If the patient does not tolerate the phenobarbital, 10 gr. (.66 gm.) doses of sodium bromide may be given instead. When various tests are to be performed, such as basal metabolism rates and tests on the fasting blood they should

be explained to the patient so that he will not be made unduly nervous by them.

Rest is probably one of the most important parts of the treatment especially in those patients showing cardiac damage because it helps to build up a definite cardiac reserve. Noland and Payne<sup>5</sup> claim that this cardiac reserve should really be the first concern in preoperative preparation. They recommended sodium bromide or one of the barbituates, however, they warned that the barbituates, in elderly patients and those with psychological tendencies and in the emotionally unstable, may produce a maniacal outburst. If this is suspected, morphine should be given and should also be given to those patients who are on the verge of crisis or delirium.

The diet should be of high caloric content, mainly carbohydrates. These carbohydrates help to safeguard the liver through glycogen storage. Means, Hertz, and Lerman<sup>20</sup> claim that excess protein in the diet is undesirable because of its specific dynamic action—it raises the metabolism. There is no specific indication for fat and may be given to whatever extent the patient demands. Soskin and Musky<sup>21</sup> reported the case of a patient treated on a high fat diet because the patient refused operation. This diet consisted of 2,790 calories made up of 230 Gm. of fat, 90 Gm. of protein and 90 Gm. of carbohydrates. This patient showed marked improvement. This is the report of only one case and is not generally recommended. Vitamin B in the form of yeast or some other preparation may be given routinely. It is of value in improving the general nutrition because it helps to increase the appetite. The diet used at the Guthrie Clinic is a balanced one containing sufficient carbohydrates to insure an adequate glycogen reserve and at times is strengthened by advising the patient to eat plain rock candy.

Patients with diabetes mellitus have definitely been made worse by their toxic thyroid, and insulin must be used to a greater degree than in a case of uncom-

plicated diabetes. The amount of insulin, of course, should be determined by frequent fasting blood sugars and frequent urinalysis. Rudy, Blumgard, and Berlin<sup>22</sup> recognized the fact that diabetes mellitus was aggravated by thyrotoxicosis and benefited by myxedema. These men also stated that a severe case of diabetes mellitus which was not controlled adequately by application of usual therapeutic measures was somewhat relieved by a total thyroidectomy, however, they do not advise this routinely for diabetes mellitus.

The daily fluid intake should be at least 3,000 to 3,500 cc. This may be taken by mouth if well tolerated. In toxic cases 5 per cent glucose in normal saline given at the rate of 60 drops a minute is of great value in rebuilding the depleting glycogen reserve of the liver and replacing the rapid loss of fluid by skin and respiration. This glucose should not be given continuously in normal saline because of the danger of producing edema. Frequent blood chloride determinations should be of help in this respect. Another cause of edema which may be confused with too much chloride intake is protein deficiency. This may be determined by the serum globulin albumen ratio. If it is a protein deficiency, small frequent blood or plasma transfusions should be given. Fluids and glucose should be pushed to a greater extent several days prior to the anticipated day of operation in order doubly to protect the patient against dehydration and liver necrosis which may follow immediately after surgery. As a matter of academic interest only, Thomas and Alexander<sup>23</sup> state that the concentration of protein in the cerebral spinal fluid is within the lower limits of normal in most cases of exophthalmic goiter and usually shows a marked increase with association in gain in weight and reduction in basal metabolism following a subtotal thyroidectomy. This, of course, plays no active part in the pre-operative treatment of this condition.

After the first World War some believed that diathermy and ultraviolet rays could

alleviate the symptoms of hyperthyroidism in the same way as roentgen therapy, however, Jackson,<sup>24</sup> in 1930, definitely stated that physical therapy has a definite place in medicine but not in the treatment of goiter.

The laboratory plays an important part in the diagnosis and treatment of most diseases and toxic goiter is no exception. The information thus obtained acts as a safe guide to treatment. Plummer<sup>25</sup> did extensive blood studies in 1918, such as hemoglobin, red and white blood cell counts and complete differentials, but found only one significant fact and that was a mononucleosis. Mahon<sup>26</sup> studied patients prior to operation, at the highest level of their postoperative reaction and again in three weeks but could draw no definite conclusions. He did bring out the fact that the sedimentation speed indicated the degreee of toxicity and that it was particularly helpful to control therapeutic effects or a treatment, especially roentgen irradiation. This test is used very little routinely.

Another popular test is the blood cholesterol determination. It is low in toxic thyroid states and is brought to a normal level partly by preoperative treatment but chiefly by subtotal thyroidectomy. Hurxthal<sup>27</sup> stated that the blood cholesterol determination is of distinct but limited value in the diagnosis of hyperthyroidism. The lowest values are found in those patients in or near a thyroid crisis. Hurxthal<sup>28</sup> also stated that the value in all types of exophthalmic goiter is lower than in toxic adenomatous goiter. Recurrent hyperthyroidism is associated with cholesterol values that are almost as low as those in exophthalmic goiter. McElroy, Schuman, and Ritchey<sup>29</sup> made the statement that while there is a general tendency for the cholesterol values to be low in hyperthyroidism, they could not demonstrate any definite inverse relationship between the degree of toxicity as measured by the basal metabolic rate and the serum cholesterol level.

Various other laboratory procedures such as complete urinalysis, fasting blood sugar determinations, blood urea nitrogen, fixation tests and serum-albumen ratio, are used mainly to determine the general condition of an individual and guide only the supplementary treatment of hyperthyroidism in case any of these tests should show abnormalities.

Very little will be said about the basal metabolic rate because most all agree as to its necessity in diagnosis and in the progress of treatment. It is not an absolute criterion as to the patient's general condition but should be correlated with subjective and objective symptoms as well. In the preoperative preparation, it is hoped to decrease the metabolic rate to a figure somewhere near or within the normal limits of plus 15 to minus 15. One reading alone should not be relied upon but the first reading should be followed by a second the following morning. No test will be altered as much as the basal metabolism rate by such things as nervousness, fright, suspense, and fever, therefore, the patient should have a complete explanation of how it is done. It should be referred to as the "breathing test" and the patient told that several will be taken during the course of the preoperative preparation. On the morning of the test, the patient should not be allowed breakfast and should be taken to the metabolism room on a carriage with as little effort as possible expended. It should be repeated every four or five days and if the treatment is adequate and proper, a gradual drop will be noted. The breathing test may also take part in the anoxic-association which will be spoken of later. Jackson<sup>30</sup> stated that the metabolic rate is not an index of the risk of operability but it gave diagnostic evidence of the presence or absence of hyperthyroidism. The test may furnish valuable information to the surgeon if it is made by a reliable machine, a reliable technician and under proper conditions. Goldberg<sup>31</sup> suggested that a consideration of the circulation time and blood cholesterol in addition to

the conventional metabolic test afforded a more accurate and balanced interpretation of the state of thyroid function than dependence on one method alone. To show further that the basal metabolism rate should be considered secondarily, Andrus and McEachern<sup>32</sup> may be quoted as follows: "The beneficial effect of iodine upon the clinical disease is primarily upon the thyroid gland and only secondarily upon the metabolic phenomena resulting from the excessive thyroid secretion." Therefore, before an attempt is made to interpret the results of metabolic studies the surgical and medical staff should be thoroughly versed in clinical studies of thyroid disease.

The management of the thyroid heart should be mentioned in preoperative treatment. The heart may show anything from a mild tachycardia to decompensation with marked arrhythmia. Ruddock and Toland<sup>33</sup> stated that digitalis should be used only in those cases that show decompensation and not in the compensated ones. Noble and Chen<sup>34</sup> pointed out that digitalis is useless in thyrotoxic tachycardia unless cardiac failure is present. Thevetin injected intramuscularly in the dosage of three to nine cat units has been suggested to subdue the cardiac activity during the preoperative period. The Eggleston method of dosage for complete digitalization is the usual standard method. A rough easy modification as given by Ruddock and Toland<sup>33</sup> is .2 gr. or .01 Gm. of the powdered leaf per pound of body weight. This gives the theoretical total amount for complete digitalization. This should be done only if no digitalis has been given for ten days. If the patient has received digitalis in the preceding ten days, the total calculated dosage should be reduced, the amount of digitalis retained allowing an average of 2.2 gr. excreted each day. If this cannot be done then the total dosage is reduced to 75 per cent and the Eggleston method followed. Quinidine sulfate is best given on the third or fourth postoperative day and will be mentioned later. Anderson<sup>35</sup> made no attempt to use

it preoperatively. From the cardiac standpoint, the time to operate is when all signs of decompensation have disappeared which is usually seven to ten days after complete digitalization. To wait longer may again subject the individual to those influences that caused the original decompensation, namely, thyroid dysfunction.

Roentgen therapy has no place in pre-operative preparation and should not be used where surgery is contemplated. It has its place in treating inoperable cases and certain selected cases, especially where operation is refused. Grier<sup>36</sup> believed that it might be used in intrathoracic goiters with or without hyperthyroidism if operation is considered inadvisable. The irradiation may reduce the size of the gland and relieve pressure symptoms.

After placing the patient on the foregoing routine and having completed the laboratory studies, when is the patient ready for operation? According to Thompson and associates<sup>37</sup> two main factors influence operative mortality and they are the condition of the patient and the skill of the surgeon. These principles appear very fundamental but require thought. Experience is the answer. No well managed clinic will hurry operation or employ unskilled operators. There are all degrees of hyperthyroidism, from the mild case to the case with impending crisis or where crisis has already occurred. For this reason each patient is an individual problem. Lahey,<sup>38</sup> in 1937, reported on 13,000 cases with 15,200 operations. In this series there were 111 deaths; 40 per cent died of thyroid crisis, 10 per cent of cardiac conditions, 10 per cent of embolism and the remaining died of carcinoma and unrelated conditions. He also believed that when a thyroid crisis eventuated, some other factors have become involved as indicated by the frequent and quite sudden occurrence at this time of a different group of symptoms; namely, vomiting, diarrhea, and temperature elevation 105 to 106°F. These other factors have to do with liver effects because of the low glyco-

gen found in patients dying with hyperthyroidism and by the fact that these individuals are so often dramatically benefited by the constant use of measures combating lowered liver function, intravenous glucose and fluids. Many surgeons do not agree with Lahey who advises operation if there is no improvement after three or four weeks' preparation. Most men agree that where the symptoms are becoming more intense, immediate operation is necessary. Lahey<sup>38</sup> further stated that any patient with cardiac damage shown by mild failure or cardiac arrhythmia should be operated upon immediately without preliminary preparation by non-operative measures, and that in almost all cases one can promise relief from incipient heart failure, a striking increase in cardiac capacity as related to suspended activity. By giving quinidine for a few days after the patient has been freed of the hyperthyroidism by operation, there is a restoration to normal cardiac rhythm in over 70 per cent of the cases. All men do not agree with this train of thought.

In cases of pregnancy and diabetes it is wise to consider immediate operative intervention because of the danger of crisis as these conditions are allowed to advance. If crisis is threatening in severe hyperthyroidism, early surgery may be advisable. The alternative is to evaluate early signs and give 40 to 60 minimis of 5 per cent glucose in distilled water intravenously per minute, day and night, together with 50 per cent glucose so that the individual will receive from 500 to 600 Gm. of glucose in twenty-four hours. Where vomiting and delirium have occurred 50 minimis (3 cc.) of Lugol's solution in 1,000 cc. of fluid intravenously should be given. Some men believe that to operate on one who has recently suffered and recovered from a crisis is to court disaster but again Lahey<sup>38</sup> disagrees in this dictioon. He advises a high carbohydrate diet for two or three weeks and stage operations with six weeks between stages. The stage

operation is seldom necessary now since modern therapy has been instituted with the aid of iodine, but still is a very useful procedure.

Lehman and Shearburn<sup>39</sup> stated that no quantitative rule governing the duration of preoperative treatment can be laid down and the individualization is an essential element in the successful handling of toxic thyroid disease.

Thompson and his associates<sup>37</sup> have shown that it is unwise to advise surgery when the patient fails to gain or lose weight, where the emotional instability and muscle weakness are marked, where the basal metabolic rate is plus 60 per cent or higher in spite of the administration of iodine, where the disease is increasing rapidly in severity, where less than two weeks have elapsed after an upper respiratory infection has cleared up, and where cardiac decompensation is present. The foregoing conclusions are contradictory to some already stated which further emphasizes the fact that individualism is the method of choice.

A modified anocci-association technic is of extreme value because the patient, especially the emotionally unstable and irritable ones, will go to the operating room in a much better condition. Crile<sup>40</sup> was the first to use this technic of "stealing the goiter." The method used in the Guthrie Clinic is as follows: The term operation is never used and the word treatment is substituted in its place. Several days before the planned operative day the patient is given either a sterile hypodermic or morphine gr.  $\frac{1}{8}$  (.0082 Gm.) in the early morning. It is explained to the patient that this is part of the treatment and can be given only hypodermically. A day or two before operation the patient is taken to the basal metabolic room for a metabolism and this helps further to alleviate the patient's fears because, on admission, two metabolism tests were made on successive days, and perhaps one or two in the preoperative régime. The morning of the operation the breakfast is

delayed as for a metabolism test and one or two hours before the operative time sodium amytal, gr. 6, (.396 Gm.) is given. The patient usually goes to sleep and does not waken until after the operation. The preoperative medication of morphine sulfate, gr.  $\frac{1}{6}$ , (.011 Gm.) and atropine sulfate, gr.  $\frac{1}{100}$ , (.00066 Gm.) is given thirty minutes before the operation. To make this method further fool-proof the operation is not listed until late the evening before and the nurses are instructed not to deviate from their regular routine care in any way. The family is not allowed to see the patient the morning before surgery but is advised of same several days in advance so that they may be present that morning.

Many anesthetics are used but the ones of choice are either ethylene or cyclopropane. Local anesthesia with novocaine is used widely in some clinics, but according to Guthrie and Woodhouse<sup>41</sup> it has little place in thyroid surgery and that the toxic effects produced by ethylene are minimal and of little consequence in comparison to the deleterious effect of an operative procedure on a conscious patient who is terrified by the manipulations attendant to a thyroidectomy, and whose terror is graphically evidenced by a mounting pulse and a state approaching crisis. Ethylene is used in this clinic and is given by anesthetists well trained in the administration of thyroid anesthesia. It has several advantages, the main ones being the margin of safety, the lack of dehydration which certain other anesthetic agents cause by a leaking skin, the quick response of the patient after the anesthetic has been stopped, the quiet, regular respirations without the secretion of mucus and the absence of anoxemia. It gives sufficient relaxation for goiter surgery because very little more than actual analgesia is required.

The Guthrie Clinic has had over 483 goiter operations without a single death and the main reason is because each patient is considered an individual problem. Guthrie reported, in November, 1940,

on the last 1,383 thyroidectomies in which the mortality rate was only 0.65 per cent. In the last thirteen years there has been only one ligation and only twenty stage operations in the 1,383 cases. This is an incidence of 1.45 per cent for stage operations. Of this group of 1,383 cases, 1,040 were considered toxic and of this number there were only eight deaths or a mortality of 0.77 per cent.

Richter<sup>42</sup> reported 270 consecutive one stage thyroidectomies on thyrotoxic patients over fifty years of age, without a death. In the same period of time, 900 thyroidectomies in every age group were performed with three deaths or a mortality of 0.33 per cent.

In summing up the paper thus far, it may be said that after complete evaluation of the patient's signs and symptoms, a reduction of the basal metabolic rate, after the weight loss has been checked or shows a gain, after the nervousness has been lessened and all contributory factors such as cardiac decompensation or associated diseases have been brought under control, the patient is ready for surgery and should be considered a safe risk.

#### CERTAIN PRINCIPLES OF OPERATIVE TECHNIC

The actual technic of the operation will not be discussed except to say that a low collar incision is used in this clinic. The operation should not be hurried but should progress as rapidly as is compatible with a well trained surgical team. Subtotal thyroidectomies rather than complete thyroidectomies are the rule in this Clinic because it helps prevent postoperative myxedema and injury to the recurrent laryngeal nerves and the parathyroids. All clamps are placed horizontal to the neck to help safeguard the nerve which is never deliberately exposed, as advised by Lahey.<sup>43</sup> The suture material used by Guthrie is fine silk and more recently cotton. This helps to prevent serum accumulations and drains are rarely needed. Clips are used to close the skin and no attempt is made to suture the fine platysma

muscle. The type of dressing used in this Clinic has proved very satisfactory. A dressing moistened in saline solution is placed above and below the clips. A dry dressing is placed over these covering the clips, and an oblong piece of sterile rubber sponge is placed so as to cover the entire incisional area. Sterile cotton wadding is next added and all held in place by a wide gauze bandage which is wrapped firmly about the neck and does not go under the armpits. Two long narrow strips of adhesive are then placed, each starting at the back and coming around the front of the bandage to the chest wall of the opposite side. This dressing is removed in twenty-four hours together with one-half of the clips. The remainder are removed in forty-eight hours. A simple gauze dressing is used after the first twenty-four hours and is removed on the fourth day. Mayo and Simpson<sup>44</sup> suggested the use of a sea sponge. During the operation, atropine gr.  $\frac{1}{100}$  (.00066 Gm.) to  $\frac{1}{200}$  (.00033 Gm.) is given if the skin shows signs of leakage and coramin or adrenalin are used as heart stimulants, if necessary.

Jackson<sup>45</sup> stated that there are six immediate complications of thyroid surgery: These are injury to the recurrent laryngeal nerve, hemorrhage, injury and collapse of the trachea, air embolism, acute hyperthyroidism and anesthetic complications. The treatment of these conditions is prevention, air embolism being one of the most dreaded complications. Guthrie and Evans<sup>46</sup> reported on a questionnaire sent to thirty-eight experienced thyroid surgeons. The result was, twenty-three had experienced no cases of air embolism and fifteen had twenty-one cases of air embolism. Of the twenty-one cases there were thirteen recoveries and eight deaths. Of these eight deaths, two were in block dissection of the neck and six were in cases of thyroidectomy. The best treatment is prophylaxis but, if it does occur, artificial respiration should be started immediately and continued. Intracardiac injections of adrenalin may be helpful.

## POSTOPERATIVE TREATMENT

The postoperative care which is as equally important as the preoperative care is now begun and the goiter team should not relax their close supervision of the case. The surroundings must be quiet and the family made to understand that for the next few days they should not bother the patient. A semisitting posture in bed with the head made comfortable with small pillows is the best position. Liquids are allowed as soon as tolerated with the exception of stimulants such as tea and coffee. In order to make up the fluid loss a proctoclysis of tap water is started immediately and continued until the patient is taking sufficient fluids (3,000 to 3,500 cc. daily). Thirty minimis (1.85 cc.) of Lugol's solution is placed in the first 1,000 cc. of the proctoclysis. Intravenous and subcutaneous fluids are resorted to only if absolutely necessary because of the discomfort they cause. In the first two days morphine sulfate gr.  $\frac{1}{6}$  (.011 Gm.) and atropine sulfate gr.  $\frac{1}{100}$  (.00066 Gm.) are given every four to six hours to combat restlessness and pain. A number of these patients do not realize that they have been operated upon until many hours after they have been returned to their room.

Many patients have considerable mucus in the respiratory tract which makes breathing difficult and uncomfortable. Means<sup>47</sup> suggested the use of compound tincture of benzoin or steam inhalations. A tube is placed in the mouth so that the patient may directly inhale the fumes. Hyperventilation with 95 per cent oxygen and 5 per cent carbon dioxide is also used to help patients raise this mucus. It is employed in the Guthrie Clinic routinely where indicated and may be done several times a day until the mucus definitely decreases in amount. Haines and Boothby<sup>48</sup> suggested oxygen therapy, in 1929, for patients having severe reactions after thyroidectomy, especially those with cyanosis resulting from pulmonary edema,

bronchopneumonia and laryngeal or tracheal obstruction. In their series of cases there was marked subjective improvement, usually the fever subsided rapidly and the pulse and respiration rates were decreased. Dyspnea was partially or completely relieved.

The oxygen tent is used extensively in this clinic and often times the patient is placed in one immediately after operation if there are any signs of respiratory or circulatory embarrassment and it is used almost entirely in the severe hyperthyroid cases to prevent postoperative reactions. An exaggerated postoperative reaction calls for large doses of sedatives, glucose, cold applications and the oxygen tent. The free use of ice bags to help reduce the hyperpyrexia is also valuable. It has been suggested that one ice bag should be used for each degree of fever.

Postoperative tachycardia need not cause alarm if the pulse is regular and hyperpyrexia and restlessness are absent. Some of the older patients will develop cardiac irregularities three or four days postoperatively and if this does occur quinidine sulfate is given. A test dose is first administered and if there are no ill effects 5 gr. (.33 Gm.) are given every four hours, day and night, for twenty-four hours. The pulse is counted before each dose and, if regular, the drug is stopped. If no improvement is noted after twenty-four hours, 5 gr. (.33 Gm.) is given every three hours for twenty-four hours and then every two hours for twenty-four hours, occasionally for forty-eight hours. Normal rhythm will usually be established with the above procedure. Anderson<sup>35</sup> stated that 96 per cent of the cases will be restored to normal rhythm if quinidine is added to the post-operative treatment where auricular fibrillation is present. He also noted that auricular flutter was noted only three times, and in two cases alternately with fibrillation; two of these cases returned to normal rhythm with the use of quinidine sulfate.

If signs of cardiac decompensation make themselves manifest, digitalis is the drug of choice. The percentage of cases in which the heart rhythm returns to normal after thyroidectomy depends chiefly on the duration of the irregularity of the heart rhythm prior to operation, the degree of arteriosclerosis and myocardial degeneration, the age of the patient, and complications such as focal infections.

Lugol's solution should be given after the first postoperative day in doses of 5 to 10 minimis (.31 to .62 cc.) three times daily while the patient is in the hospital. The average dose in this clinic is 8 minimis (.48 cc.) three times a day. The first postoperative day is taken care of by the 30 minimis (1.85 cc.) given in the enteroclysis. In very mild toxic cases, iodine may be omitted entirely postoperatively but will do no harm. Davison and Aries<sup>49</sup> claim that if sufficient gland has been removed and if the patient has been prepared adequately preoperatively, the use of postoperative iodine has no rational basis. They studied a series of 100 cases in which fifty of them had been given iodine postoperatively and fifty had been given no iodine. Those patients in whom no iodine had been given had milder reactions. It is definitely indicated, however, in such incomplete operations as polar ligations, lobectomy and the removal of discrete adenomas and in all cases in which there has been residual thyroid tissue left behind, necessitating protective iodinization. If the operation has been successful, iodine need not be given after the patient is discharged from the hospital.

Postoperative hemorrhage demands immediate attention or it may prove fatal. The immediate separation of the wound and expression of the clots may be necessary in the massive type to prevent suffocation. Concealed hemorrhage should be taken care of early before symptoms become severe. The patient is taken back to the operating room, the wound opened, clots expressed and the bleeding point ligated with accuracy.

Serum pockets, if large, should be drained and if very small, they may be absorbed without any treatment. If a drain has been used, it should be removed in twenty-four hours. The strictest asepsis should be used in dressing all goiter wounds because infection is borne poorly by these patients.

The basal metabolic rate is taken before the patient leaves the hospital and in three months after discharge to determine whether or not any hyperthyroidism or hypothyroidism is present. If these are suspected, the patient should return for observation and the institution of proper medical treatment.

Postoperative laryngoscopy should be performed to determine the condition of the larynx before the patient leaves the hospital. This examination, together with the one done preoperatively, will often determine whether a voice difficulty was due to operative injury or whether the difficulty is a transient or a permanent one.

The subject of thyroid crisis should receive some attention; although uncommon today, it still occurs. Pemberton<sup>50</sup> stated that perhaps in every operation for active goiter some reaction of hyperthyroidism occurs. When the patient has been properly prepared preoperatively this reaction is so mild that clinically it can scarcely be distinguished from the normal postoperative response and it differs only in increased sweating, a moderate rise in temperature and pulse rate and perhaps in the development of intermittent irregularity of cardiac rhythm. These symptoms as a rule do not develop until six to twelve hours or even longer and usually subside within twenty-four to forty-eight hours without materially influencing the patient's convalescence. The more severe hyperthyroid reactions differ only from the typical crisis of the pre-iodine period in that they are not accompanied by the extreme mental agitation, the restlessness and the general toxic state as previously seen. The treatment of crisis consists of oxygen therapy, ice

bags, sedatives (morphine in the more severe cases) and intravenous glucose and fluids. Iodine in large doses may be decidedly helpful. The best treatment, however, is preventative, that is, adequate preoperative preparation.

Maddock, Pederson and Coller<sup>51</sup> stated that with further knowledge of the cause of thyroid crisis, specific measures may be possible to avoid this serious complication.

Delirium and confusion may follow thyroidectomy. It usually occurs in patients more than sixty years of age, who are emaciated, feeble and have had hyperthyroidism for several years. Dinsmore and Crile<sup>52</sup> claim that confusion can usually be demonstrated to be the result of liver failure, kidney failure, the cumulative effect of some drug or an unclassified type of metabolic exhaustion. The treatment of these conditions is the administration of glucose.

Exophthalmos is usually expected to decrease after thyroidectomy or to disappear entirely. Often the ocular changes are very slow in improving, gradual recession taking place many months after operation. In the more severe cases exophthalmos may remain permanently. Zimmerman<sup>53</sup> stated that in eight cases of hyperthyroidism, exophthalmos developed after the operation. There is no definite explanation for this phenomenon. Malignant or progressive exophthalmos may also occur and is a very unfortunate thing to have happen. Most patients that develop this are in a hypothyroid state. Treatment is difficult and operations have been designed for this condition but are not always successful.

Tetany is a harassing thing for the surgeon if it occurs postoperatively. The best treatment is again prevention, that is, the protection of the parathyroids from actual removal or trauma during operation. If they are removed, they should be transplanted immediately. No cases of tetany were seen in the cases reported.

If active tetany occurs, parathormone should be given during the acute stage with calcium salts by mouth or intraven-

ously. Clifton<sup>54</sup> believes that the chronic cases should be given a high carbohydrate diet with calcium in large doses. Eppinger and Levine<sup>55</sup> found tetany to be an infrequent complication following total thyroidectomy. They recommended 5 to 10 minims (.31 to .62 cc.) of viosterol and 4 to 8 Gm. (approximately 60 to 120 gr.) of calcium lactate daily for a period of from two to three weeks, and in no instance was parathyroid extract needed. Guthrie and Brown<sup>56</sup> reported in 1939 the absence of permanent tetany in over 4,100 cases.

The diet following thyroidectomy is relatively simple. The patient is allowed liquids as soon as tolerated except stimulants such as coffee or tea. On the third day a modified soft diet which consists of toast, jello, etc., should be allowed. Following this a soft diet is given. This consists of everything except meat. The regular house diet which should be of a high carbohydrate content is well tolerated by the patient on the fifth or sixth day. The soreness of the throat which is prevalent in the first few days should have subsided by this time. Of course, post-operative nausea and vomiting may modify this régime to a certain degree and each individual case will have to be dealt with accordingly. Associated conditions such as diabetes mellitus should receive their special diets as determined by frequent blood sugars. These diets are covered with insulin according to the needs of the patient.

The care of the bowels is important. Milk of magnesia in doses of 1½ ounces (45 cc.) is given on the second or third day if necessary; liquid cascara, drachms 1, (4 cc.) is equally effectual and perhaps better in many cases. A saline enema may be required if postoperative distention occurs. The normal bowel habits of the patient should be instituted as soon as possible.

Associated diseases are treated just the same as if the thyroid condition had not entered the picture. A marked reduction

in many cases of hypertension is noted without any further treatment. Symptoms which have been diagnosed as other diseases may often disappear. This is especially true of vague abdominal symptoms. Since the thyroid is so intimately connected with the endocrine chain, it is easily understood why these symptoms are either relieved or abated entirely.

The chair is allowed on the fourth postoperative day if the convalescence up to this time has been uneventful. Walking is allowed on the fifth day, usually just bathroom privileges. After this, the patients are allowed gradually to increase the walking each day but they are kept on limited activity the entire postoperative period and are advised to continue the same after going home.

The average time for discharge in this clinic is ten days, however, this varies considerable depending on the postoperative course. Those patients who show marked signs of cardiac damage and severe hyperthyroidism may be advised to stay for a much longer period of time. Experience of the medical staff should be allowed to control this factor as well as guide most of the postoperative care. Guthrie<sup>57</sup> pointed out that the older patient who shows the effect of prolonged and severe toxemia should have long periods of rest under strict and intelligent medical supervision but the younger patient who has no symptoms of vascular, hepatic or renal damage may be returned to partial activity soon after their arrival home. These patients should be advised to return if any questions as to their well being arises, and it is well to keep in touch with them for at least one year, or longer if necessary. This is not only for the good of the patient but it will also act as a gauge for the thyroid team to determine whether or not their treatment has been successful. In many cases it is gratifying to both the surgeon and internist to see these patients being returned to society normal individuals.

#### ANALYSIS OF CASES REVIEWED

The preoperative and postoperative treatment as given in this paper is not only derived from the voluminous literature on the subject but also on the analysis of 100 cases treated in the Guthrie Clinic. These were taken from the records of 1938 and 1939, and represent the typical cases taken care of in this clinic. Cases representing all degrees of toxicity are included in this series and it might be interesting to note that there was no mortality. This analysis will be given in the following paragraphs to bear out the statements already made. Certain details of laboratory findings and signs not already mentioned will also be discussed such as blood and urine studies.

This series represented forty-nine cases of primary hyperthyroidism and fifty-one cases of toxic adenomatous goiter. This near equality of cases should give a relatively concise cross section of the same. There were ninety-one females and nine males ranging in ages from nineteen to seventy years, the average age being forty-seven years. A subtotal thyroidectomy was performed on each of these patients. The amount of tissue allowed to remain was judged by the experience of the surgeon and degree of toxicity. It varied from one-fourth to one-eighth of the gland. Silk technic was used throughout, drains were placed in three cases, every wound healed by primary intention and serum pockets formed in only eighteen cases. The sternohyoid muscle was divided in thirty-one cases to form a unilateral trap door and in ten cases to form a bilateral trap door. Fifty-nine cases required no trap door. This was done for safety in removing the gland. The general condition of the patient during the operation was considered good except in two cases and these two were classified as fairly good. The average time of operation was fifty-eight minutes, however, this should not be stressed as important because haste is not necessary with a well prepared patient.

Adequate time should be taken to secure hemostasis and safeguard the many vital structures such as parathyroids, recurrent laryngeal nerves, trachea and the great vessels of the neck.

On admission many of these patients showed some degree of fever, the highest being 104.3° F. in a patient admitted with bronchopneumonia. This was controlled by sulfapyridine. The average pulse rate was 105, which dropped to 88 after adequate treatment. During the operation the average pulse was 120. The peak following operation was 114 which gradually declined to 80 at the time of discharge. These averages give a very clear picture of what happens in the average case.

The number of days required for preparation was eleven, the maximum number being 30. This short length of time of preparatory treatment may be influenced by the fact that a few of the patients were treated at home and came well prepared. The average postoperative days were ten, the maximum being eighteen. The reason for this extended hospital stay postoperatively was due to a second operation, the excision of a lipoma. The patients were usually gotten out of bed on the fourth day.

Iodine was administered preoperatively in the form of Lugol's solution, the average dose being minims 15 (.92 cc.) three times a day. This also varied from minims 10 to minims 20 (.62 to 1.23 cc.) depending, of course, upon the toxicity of the case. Thirty minims (1.85 cc.) of Lugol's solution was given immediately after operation in the first 1,000 cc. of proctoclysis. On the second day Lugol's solution, minims 8 (.48 cc.) three times a day, was the average dose, this amount varied also depending upon the needs of the patient and in most cases was continued until the patient left the hospital. No iodine was advised after the patient left the hospital.

The blood picture was not unusual except the presence of a mild secondary anemia. The hemoglobin estimations showed an average of 75 per cent and red blood cells 4,089,000. The white blood

cells were essentially normal, the average being 6,573, of which 63 per cent were polymorphonuclear cells and the remaining 37 per cent were small lymphocytes. An occasional case showed a slight eosinophilia.

The average blood cholesterol reading was 150 mg. per 100 cc. of blood; this was within the lower limits of normal which ranges from 140 to 200 mg. The lowest cholesterol readings were 96, these being in very toxic cases.

The blood urea nitrogen was 15 mg. per 100 cc. while the fasting blood sugar average was 97 mg. per 100 cc. of blood. These readings were of no particular significance except to show that the kidneys were eliminating waste products properly and to show the presence or absence of diabetes. There were several cases of diabetes but these were well controlled by diet and insulin.

The Kahn test was the predominant one used to show the presence or absence of syphilis. It was positive in two cases and in one of these a Wassermann was done which was negative. Syphilis is not as prevalent in this section of the country as it is in urban areas.

The routine urine examination showed an average specific gravity of 1.016. A number of cases showed some albumen and those with diabetes mellitus varying amounts of sugar.

Since there were so many factors that influence the metabolic rate it is almost impossible to give accurate figures. An attempt was made to analyze the rate in this series and it was found that the average metabolic rate on admission was plus 42. This figure was reduced to plus 32 before operation under appropriate treatment and just before discharge the rate had dropped to plus 12. These figures probably do not agree exactly with other clinics, but they do show that the drop sought for had been obtained.

Weight gain is one important criteria of a successful thyroid treatment regimen. From the time of admission for the treatment until the routine check-up, the

average weight gain in seventy-seven of the 100 cases was twelve pounds. Since twenty patients did not return for a check-up and in three the weight records were not complete, the average was taken for the seventy-seven cases.

The anoxic-association technic was carried out in eighty-eight cases. The average dose of sodium amyntal given was 6 gr. (.396 Gm.) while several received but 3 gr. (.198 Gm.). The usual preoperative hypodermic of morphine sulfate  $\frac{1}{6}$  (.011 Gm.) and atropine sulfate gr.  $\frac{1}{100}$  or  $\frac{1}{150}$  (.00066 or .00044 Gm.) was used in all the cases except two. In one of these cases amyntal gr. 3 (.198 Gm.) was used instead of the preoperative hypodermic and in the other case codein gr. 1 (.066 Gm.) was substituted for morphine. No reason was given for the first but the latter case could not tolerate morphine.

Ethylene anesthesia was used exclusively. The usual ethylene-oxygen ratio is 80 to 20 but cases of extreme toxicity required a higher percentage of oxygen. Before the anesthetic was started, the anesthetist was advised as to the relative toxicity of the patient so that the ethylene-oxygen mixture could be arranged accordingly.

Thyroidectomy showed a decided beneficial effect on nine cases of hypertension. According to Hurxthal<sup>58</sup> the pulse pressure is increased in hyperthyroidism and decreased in about 50 per cent of the patients following relief from thyroid toxicity. Generally speaking this was true in our series of cases in which the blood pressure was studied and especially true in these nine cases of hypertension.

In reviewing the postoperative complications, heart irregularity was the most common. This should really not be classified as a complication because many of the cases showed considerable cardiac damage before operation. In several of the cases, fibrillation did not present itself until the second or third postoperative day. This fibrillation did not always require medication because it cleared up spontaneously

within a short period of time. In the more severe cases of fibrillation, quinidine was used with excellent results. One patient who had been seen in the clinic many times with severe cardiac damage died three months after discharge; this was presumably a cardiac death. Quinidine, digifolin and digitalis had been used on this case at various times. Two patients developed postoperative hypothyroidism, one with a basal metabolic rate of minus 22. There was one case of pleurisy, one toxic psychosis, one pulmonary atelectasis of the left lower lobe of the lung, one acute pyelitis, and one pulmonary infarct. These patients all recovered. One patient showed some infection of the wound about one month after discharge which cleared up after several suture knots were removed. No cases of thyroid crisis were noted in this series. The benefits that most of these patients derived from their thyroidectomy far out-weighed any of the complications that arose except the one who died three months after being discharged from the hospital. This patient probably received no gross benefit from the treatment.

All the patients were advised to return for a routine check-up, the average time being about six weeks. Many were told to return much sooner, especially if it was thought advisable because of individual circumstances. Out of the 100 cases, eighty returned and twenty did not. The results were generally good in all but three; one of these had arteriosclerotic heart disease, the second had hypothyroidism and when given thyroid extract showed improvement, and the third had hypertensive heart disease, questionable lues and calcification of the aortic arch.

An attempt has been made to discuss fully the general trend and ideas of treatment as set forth in the voluminous literature on the subject of the preoperative and postoperative treatment of the toxic thyroid. In order to further substantiate these data, 100 typical cases from the Guthrie Clinic have been re-

viewed and the information gained has been discussed.

### CONCLUSIONS

The evolution of the treatment of toxic goiter has extended over many centuries. This treatment has had a more rational basis since more is understood of the physiology and chemistry of the thyroid gland.

The general practitioner, as well as the clinic, play a very important rôle in the early treatment of this condition.

Scientific preoperative iodine therapy is the most important phase in the presurgical treatment. Its value postoperatively is without question.

The laboratory is so closely linked, with both diagnosis and treatment of the toxic thyroid, that its value should not be lost sight of throughout the entire course of the disease, preoperatively, surgically, and postoperatively.

Associated diseases require the same careful preparation as does the diseased thyroid.

Acci-association is of distinct advantage in keeping the patient in that state of restfulness which is so much desired at the time of operation.

Ethylene anesthesia is the anesthetic of choice.

The well prepared patient will be one whose major symptoms have subsided, whose confidence is irreproachable, and in the minds of both surgeon and internist is a safe operative risk.

One stage subtotal thyroidectomies should be performed wherever possible, and only in the most severe cases should a two-stage operation be advised.

Non-absorbable suture material, silk or cotton, is preferable to catgut.

The oxygen tent is a valuable aid in relieving respiratory or circulatory embarrassment.

Postoperative hemorrhage is a serious complication and must receive immediate attention.

Some cases of hypertension associated with hyperthyroidism receive definite benefit from thyroidectomy.

Each patient, being treated for hyperthyroidism, must be considered a definite problem of individualism in the preoperative and postoperative treatment.

The analysis of 100 cases have been presented to substantiate these facts.

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# THE EFFECTS OF PYRIDIUM IN CERTAIN UROGENITAL INFECTIONS\*

THOMAS J. KIRWIN, M.D.,

Diplomate of the American Board  
of Urology

OSWALD SWINNEY LOWSLEY, M.D.

Diplomate of the American Board  
of Urology

AND

JOSEPH MENNING, M.D.

NEW YORK, NEW YORK

**I**N 1940, Morrissey and Spinelli<sup>1</sup> published a report on the clinical employment of pyridium, in which they stressed its beneficial analgesic and anesthetic effects on the urogenital mucosa. During the course of their study, they noted a reduction of from one-half to two-thirds of the amount of urinary sediment in surgical cases receiving pyridium. Pointing out that this portion of the study had been somewhat limited, they suggested a further investigation of this effect of pyridium.

In 1941, Braitberg<sup>2</sup> published the results of such an investigation. In this study, 80 per cent of the cases of urinary tract infections treated with pyridium showed a 50 per cent or more decrease in organized urinary sediment. With very few exceptions, a reduction of urinary sediment was accompanied by a decrease or disappearance of the subjective symptoms.

The purposes of the present study are: (1) to confirm the limited observations made by Morrissey and Spinelli on this effect of pyridium, and (2) to confirm and extend Braitberg's findings, with special reference to correlating the effect of pyridium in reducing the organized urinary sediment and its well known action of relieving the distressing symptoms of urinary tract infection.

## HISTORY OF DRUG

Pyridium is the brand name for phenyl-azo- $\alpha$ - $\alpha$ -diamino-pyridine monohydro-

chloride. This azo dye first came into general clinical use among American urologists toward the end of the 1920's. Upon its original introduction, special stress was placed upon its marked powers of tissue penetration. Thus, as early as 1927, Bellfield and Rolnick,<sup>3</sup> Chicago urologists, had noted that on microscopic examination of spermatic fluid ejaculated by a patient under treatment with pyridium, the heads of the spermatozoa were stained with a yellow coloration characteristically produced by this drug. This was an emphatic confirmation of the claims of powerful penetrative action.

No attempt will be made here to review all of the many published reports on the clinical use of pyridium in urogenital infections. By 1934, clinical reports thereon had been made by urologists so often that Walther and Willoughby<sup>4</sup> undertook a general evaluation of its merits and limitations through a survey of the literature and classification of the accumulated data. Among the many papers cited by these authors was that of Mason,<sup>5</sup> published in 1931. This investigator attested especially to the benefits which patients with prostatitis had received from pyridium therapy, both prior to and following operation, as well as in those cases in which surgical procedures had not been employed.

Most of the authors who have studied the clinical effectiveness of pyridium have made some statement indicating how closely pyridium approaches the "ideal

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"antiseptic" for urinary infections—that touchstone so long but *rarely* sought by all who cultivate the special field of urology. No one, so far as we are aware, has ever reached that ideal, but it is an objective of the present contribution to show further progress in that direction.

#### EFFECTS OF PYRIDIUM ADMINISTRATION

The beneficial effects of pyridium therapy in urogenital infections are well established. Walther<sup>6</sup> stated that he had found the sphere of usefulness of this type of drug a wide one, because it is equally effective in an acid or an alkaline medium, requires no special dietary regimen, and has a soothing effect on the inflamed mucous membrane. He believes that a large part of the usefulness of this type of drug lies in its capacity to penetrate the tissues and attack the bacteria in their own habitat. Mason's<sup>5</sup> outstanding results following the use of pyridium were obtained in cases of acute, subacute, and chronic prostatitis and also in chronic and subacute pyelitis and pyelonephritis. Freedom from all clinical symptoms, together with results

of careful weekly urine analyses, convinced him of the marked benefit obtained from pyridium therapy. Braitberg's<sup>2</sup> work on organized urinary sediments has already been noted.

#### BASIS OF THE PRESENT STUDY

The present study is based on a series of 118 cases, all under observation for two weeks or longer. Various types of urinary infection were treated with pyridium, the usual dosage being two tablets of 0.1 Gm. each, administered three times daily. Twenty-four-hour specimens of urine were collected from each patient for several days before pyridium therapy was instituted, and the final specimen secured two weeks later, while the patient was being maintained on the pyridium regimen.

At each examination the influence of pyridium in reducing the amount of organized urinary sediment was noted by comparison with previous records; at the same time, careful attention was accorded the characteristic symptoms of urinary infection which the patient exhibited, whether unabated, lessened, or entirely

TABLE I  
ANALYSIS OF 118 CASES TREATED WITH PYRIDIUM

Diagnosis	No. Cases	Frequency		Dysuria		Burning		Nocturia		Cases Showing Reduction in Sediment
		No. Cases	Improvement							
Cystitis and pyelonephritis.	75	70	60 (85.7%)	28	27 (96.4%)	52	49 (94.2%)	54	48 (88.8%)	43 (57.3%)
Prostatic hypertrophy.	14	13	12 (92.3%)	4	4 (100.0%)	6	6 (100.0%)	14	11 (78.6%)	8 (57.1%)
Postoperative: Following resection of prostate (carcinoma).	18	17	15 (88.2%)	8	7 (87.5%)	12	11 (91.6%)	16	13 (81.2%)	11 (61.1%)
Urethritis.....	9	9	6 (66.6%)	2	2 (100.0%)	8	7 (87.5%)	6	3 (50.0%)	1 (11.1%)
Diverticulitis*.....	2	2	2 (100.0%)	1	1 (100.0%)	1	1 (100.0%)	2	2 (100.0%)	2 (100.0%)
Total No. cases.....	118	111	95	43	41	79	74	92	77	65
Average per cent of improvement.....	...	...	85.6%	..	95.3%	..	93.6%	..	83.7%	55.1%

\* This is obviously not a significant number of cases. They are included merely to complete the series.

abolished. A summary of our observations appears in Table 1.

These results support the observations of Morrissey and Spinelli<sup>1</sup> and of Braithberg.<sup>2</sup> They also are in accord with the findings of Reynolds, Wilkey, and Choy,<sup>3</sup> as well as those of many other investigators who have observed the effectiveness of pyridium in relieving the characteristic symptoms of urinary infection.

#### DEFINITION OF ORGANIZED SEDIMENT

In speaking of "organized sediment," granular, epithelial, blood and other pathologic casts have been excluded. The unorganized sediment (salts) was excluded because its presence in the voided urine depends upon many factors unrelated to urinary tract infection, such as diet, hydrogen-ion concentration, enzyme action, or temperature changes affecting collected urine.

#### METHOD OF SECURING SPECIMENS

In securing the specimens we used Goetz phosphorus centrifuge bottles, 100 cc. volume, with 1 cc. tip capacity, which were calibrated in .05 cc. graduations. Four-liter brown specimen bottles were employed, 5 cc. of a 10 per cent solution of thymol being placed in each bottle before the urine was added.

#### DETERMINATION OF AMOUNT OF SEDIMENT

The following standardized technic was carried out in estimating the total amount of organized urinary sediment:

1. Shake bottle containing twenty-four hour specimen vigorously until sediment is evenly distributed.

2. Immediately pour 150 to 200 cc. into a beaker.

3. While gently stirring, add 10 per cent hydrochloric acid, drop by drop until hydrogen ion concentration is 5.5. Nitrazine paper SPOT test.

4. Add the urine at hydrogen ion concentration 5.5 to the 100 cc. centrifuge bottle, and pour the remainder back into the twenty-four-hour specimen bottle.

5. Measure the volume of urine from specimen bottle into a 100 or 200 cc. graduate; add 100 cc. for that used in sample for analysis.

6. Place centrifuge bottle in the proper holder and centrifuge for fifteen minutes at the rate of 1,800 revolutions per minute.

7. Record sediment percentage and volume. The total organized sediment will equal the volume times the sediment percentage over 100.

$$\frac{\text{Volume} \times \text{Sediment Percentage}}{100} = \text{Total Organized Sediment}$$

#### COMMENTS

The patients were divided into four groups. In Group 1 there were twenty-nine patients who complained of such symptoms as frequency, urgency, burning, and intermittent pain. They were almost equally divided as to sex, fifteen being females and fourteen males. Duration of symptoms prior to the administration of pyridium varied all the way from "a few days" to "several years," "several months" being the period most frequently reported on the history charts.

Of this entire first group, only two patients were reported as receiving no benefit whatever from the medication. In practically every case in which dysuria had been a common symptom, the pain either disappeared completely or was greatly reduced following the course of pyridium therapy. In most cases in which frequency and nocturia were originally the chief complaints, once treatment with pyridium was instituted the intervals between bladder evacuations were lengthened, and sleep became possible without interruption in all but a few exceptions.

In this group, reduction of the organized urinary sediment was equally striking. In one case of chronic pyelonephritis and cystitis, not only was there complete relief of symptoms, but the amount of urinary sediment fell from 0.18 cc. per 100 cc. of

urine at the beginning of treatment, to .05 cc. after two weeks of pyridium therapy. In another case, the total sediment fell from 0.15 cc. per 100 cc. of urine to .06 cc. In a number of cases, the amount of organized urinary sediment remained practically constant, although in these cases also there was marked symptomatic improvement.

Group II was made up of thirty patients, most of whom were hospitalized for such serious urologic conditions as renal calculus, prostatic hypertrophy, carcinoma, chronic cystitis, and pyelonephritis. Although this group contained a majority of females, some of the most striking results occurred in males with prostatitis, especially those whose infections occurred postoperatively. In the case of two female patients, no improvement was noted after a full course of pyridium, and in general, results were not so good in this group as in Group I. It should be noted, however, that the pathologic conditions in the patients which comprised this group were of much longer standing and were associated with more profound systemic disturbances than prevailed in the first group.

Group III contained thirty-five patients, twenty-five of whom were females. The urogenital conditions in this group also were more severe and of greater duration than those in Group I. One patient, a man of seventy-five years, suffered with an inoperable carcinoma of the prostate and urinary infection of several years' standing, complicated by a serious cardiovascular syndrome. Nevertheless, even in this undeniably hopeless condition, regular pyridium administration reduced the urinary sediment from .06 cc. per 100 cc. of urine to .04 cc., while the general condition showed far more improvement than the statistical results reported in the accompanying table would indicate. Another patient, a man of sixty-seven years, with acute pyelonephritis and uremia of several weeks' duration, had a total daily urine output of but 700 cc. at the beginning of treatment, with sediment of 0.12 cc. per

100 cc. After the two weeks' course of treatment, the twenty-four-hour urinary output increased to 1,600 cc., whereas the total organized urinary sediment fell to .04 cc. per 100 cc. In a woman, age thirty-eight, with cystitis, the volume of urine fell from 1,500 cc. to 1,200 cc., but the amount of urinary sediment likewise declined from .06 cc. to .03 cc. per 100 cc. In but one case in this group was there a significant increase in urinary sediment, with a comparative lack of improvement in the associated symptoms. A small number of patients in this group showed no significant improvement following the regular course of this medication.

Group IV consisted of twenty-four patients, whose conditions were largely post-operative, and with the exception of one young woman, age twenty-four years, the patients were all of advanced age. In this group the least objective benefit appears to have been obtained from pyridium therapy, for there was a marked reduction in the amount of urinary sediment in but four cases. The reasons for this lack of response to measures which had proved so beneficial in the first three groups seem to us to be entirely apparent in the nature of the cases, which were for the most part long-standing, neglected urinary infections in patients of advanced age and general lack of resistance.

#### CASE REPORTS

The following case histories have been selected as representative of the various groups discussed:

GROUP I. C. S., female, age thirty-four, complained of frequency and urgency of several weeks' duration, with burning on urination. At the time of admission, the volume of urine varied from 1,500 to 1,600 cc. and the urinary sediment varied from 3 to 0.18 cc. per 100 cc. Diagnosis was right renal calculus with right-sided pyelonephritis and cystitis. The patient was placed on the pyridium regimen consisting of two tablets of 0.1 Gm. each, three times daily. At the end of the first day of pyridium therapy, the volume of urine de-

creased to 1,260 cc., with urinary sediment of 4 cc. per 100 cc. The following day the volume was reduced still further to 820 cc., with the percentage of sediment remaining unchanged. Thereafter improvement was steady, so that on the fourteenth day volume of urine had reached 1,850 cc. whereas the urinary sediment was reduced to 1 cc. per 100 cc. Relief of symptoms was complete.

**GROUP II.** A. M., female, age seventy-six, complained of frequency and burning on urination. This patient had been obliged to arise two or three times during the night, intermittently for several months. The tentative diagnosis was cystitis and the patient was placed on the regimen of two pyridium tablets of 0.1 Gm. each, three times daily. On admission, the urinary volume was 1,630 cc. and the sediment percentage 18. The second day following admission, the urinary volume was 1,600 cc. and the sediment percentage only 2. However, on the third day, with the volume at 1,700 cc., the sediment again was 18 per cent. This setback proved to be only temporary, however, for by the fourteenth day, even though the volume had increased to 1,900 cc., the sediment was down to 3 per cent. Furthermore, the patient was able to retain urine for three or four hours during the day, and was compelled to arise only occasionally during the night.

**GROUP III.** C. G., female, age fifty-nine, had suffered for two years with dysuria, frequency, and nocturia. There was sharp pain on urination, followed by burning, and she was obliged to arise six or seven times during the night. The diagnosis was chronic pyelonephritis, cystitis, and stricture of the urethra. On admission, the volume of urine was 1,100 to 1,200 cc., and the sediment was .04 cc. to .06 cc. per 100 cc. Routine pyridium therapy was instituted after a preliminary trial of sulfathiazole had been made without benefit.

Because of clinical remission of symptoms, pyridium therapy was suspended, after which all the original symptoms promptly recurred. These were again controlled with pyridium therapy. On the fourteenth day, the intervals between urination had increased from one hour on admission to four or five hours. All pain and burning had ceased, although the patient was still obliged to arise once, or sometimes twice, during the night. The volume of urine remained practically unchanged, but the organized urinary sediment fell to .03 cc. per 100 cc.

**GROUP IV.** C. O'C., age eighty-three, had undergone transurethral resection for carcinoma of the prostate. His chief postoperative complaints were frequency, sharp pain and burning during micturition, and the necessity of arising two or three times at night to urinate, which constituted a severe strain on this patient's physical condition. On the first day of pyridium therapy, the urinary volume was 1,800 cc., but the following day it fell to 1,600 cc. Urinary sediment remained at 0.6 cc. per 100 cc. throughout. Fourteen days after pyridium therapy had been instituted, this elderly patient was able to retain urine from three to five hours, no pain was experienced when urinating, and he was forced to arise not more than twice, and often only once, during the night. Although the urinary volume subsequently rose to 2,000 cc., urinary sediment was only 3 per cent.

#### TOXICITY

Recent developments in the field of chemotherapy have focused merited attention on the too often neglected question of drug toxicity. With this in mind, each patient receiving pyridium was carefully questioned and observed for evidence of any toxic effects attributable to this drug. Without exception, no toxic effects were observed. From these observations it appears that pyridium may be administered, in therapeutic dosage with complete confidence in its safety and lack of toxic effects throughout the usual course of urinary infections.

#### SUMMARY

A study was made of 118 cases of urogenital infections. Routine pyridium therapy administered for a period of two weeks resulted in a significant reduction of the organized sediment in sixty-five, or 55.1 per cent of the cases, together with relief of the characteristic symptoms of urogenital infection. In the remaining fifty-three cases, relief of symptoms occurred in all but a few exceptions, although there was no concomitant reduction in the organized urinary sediment.

Relief of the distressing symptoms characteristic of urogenital infections occurred

as follows: Pain on urination was alleviated or abolished in 95.3 per cent of the cases; burning on urination was relieved in 93.6 per cent of the cases; the intervals between bladder evacuations became normal or were greatly extended in 85 per cent of the cases; and nocturia was eliminated or reduced in 83.7 per cent of the cases.

Careful observation revealed no toxic effects from routine administration of this drug, in the dosage of two tablets (0.1 Gm. each) three times per day, throughout a minimum period of two weeks.

#### CONCLUSIONS

Pyridium has proved to be a valuable addition to the physician's weapons against infections of the urinary tract.

In a significant number of cases, it has been found to be effective in reducing the amount of organized urinary sediment, and especially in relieving the characteristic symptoms of urogenital infections, such as dysuria, burning, frequency, and nocturia.

Relief of symptoms occurred in most instances even when no decrease in the amount of organized urinary sediment was observed.

Pyridium may be administered in therapeutic dosage with complete safety throughout the course of common urogenital infections.

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# PROGNOSIS IN PROLONGED UNCONSCIOUSNESS FOLLOWING HEAD INJURY\*

C. D. HAWKES, M.D.

Fellow in Neurosurgery, The Lahey Clinic

BOSTON, MASSACHUSETTS

UNCONSCIOUSNESS which persists for a period of days in a patient who has suffered a severe craniocerebral injury is a source of anxiety to the family and friends of the individual, and of perplexity to the attending physician. Most neurosurgeons have had a sufficient experience with such cases as to have formed an impression of the outlook, but in a general hospital the resident staff as well as the family physician or surgeon are beset by doubts both as to the proper care of such patients and as to what prognostic assurance they may legitimately give the family. This is particularly true when the neurosurgical consultant cannot always be immediately available, as is frequently the case. Singularly enough little information is available either in textbooks or in the literature. The purpose of this paper is to lay the groundwork for a scientific clarification of this situation.

Any problem involving a discussion of the unconscious state necessarily requires a definition of the sense in which the term is used, since it is loosely applied to a wide variety of conditions ranging from profound coma to mild delirium or stupor. For the purposes of this paper a patient will be considered to be unconscious when he appears neither to have knowledge of his surroundings nor to perceive the stimuli which are directed at him. This concept is based on the opinion of Mapother (1937) that "the only practicable criterion of 'recovery of consciousness' is awareness of external environment and accessibility." When a patient attains this level, he falls into a group which is well recognized by everyone, since a moderate degree of post-traumatic amnesia and stupor are com-

monly seen sequelae of even relatively mild craniocerebral injuries. Therefore, a less strict interpretation of the meaning of unconsciousness, while it would provide a larger number of cases to report, would also mean the inclusion of cases in which the same therapeutic problems and the same concern do not obtain, and accordingly is not employed.

It is well known that by far the greater proportion of deaths among cases of craniocerebral injury occur in the first twenty-four hours and that the majority take place in less than 72 hours. These facts are amply demonstrated by the survey made by Courville (1937) of 919 cases of injury to the brain and its envelopes coming to autopsy in the Los Angeles County Coroner's Department. His figures indicate that approximately 70 per cent of the deaths occurred in the first twenty-four hours plus an additional 10 per cent in the next forty-eight hours. The remaining 20 per cent were spread over a period of weeks. Of course, this series included a number of deaths occurring at once, a group which does not enter into statistics compiled from hospital admissions. However, Jefferson (1933) has reported a large series of cases among which there were 152 deaths, and of these 119, or 79 per cent, occurred in the first seventy-two hours. Taken all in all the first twenty-four hours is to be regarded as the most critical, the first three days as the relatively critical period. Thereafter the mortality is only 3 to 4 per cent (Jefferson, 1933; Swift and Berens, 1938).

It is likewise true that the greater proportion of patients with craniocerebral injuries recover consciousness in the first

\* From the Department of Surgery, The Union Memorial Hospital, Baltimore.

twenty-four hours. Russell (1932) reported that 137 or 69 per cent of 200 patients with head injuries regained consciousness within twenty-four hours, and the figures of Eden and Turner (1941) are comparable. However, it is the group of patients who remain unconscious for longer than the seventy-two-hour critical period with whom this study is concerned, and it will be shown that they constitute the greater proportion of those patients who do not regain consciousness in the first twenty-four hours.

TABLE I

Period of Unconsciousness	No. of Cases	Deaths	Mortality, Per Cent
Less than 24 hours.....	181	81%	13
24 to 48 hours.....	10	4½%	7
48 to 72 hours.....	3	1½%	2
Greater than 72 hours...	30	13%	5

Table I. The 224 cases of cranioerebral injury studied are grouped according to the duration of the period of unconsciousness. The number of deaths in each group together with the mortality rate is given.

### RESULTS

For the purposes of this paper a survey of all the cases of head injury admitted to the Union Memorial Hospital from January 1, 1937, to March 31, 1942, was made. These numbered 261. Of these thirty-seven had given no history of unconsciousness

nor of retrograde or post-traumatic amnesia and were obviously of such a trivial nature as to justify their elimination from any series of craniocerebral injuries on the same grounds that Coleman excluded 143 of the 596 cases he reported in 1931. Among the remaining 224 patients of the present series 181 were unconscious less than twenty-four hours, ten from twenty-four to forty-eight hours, three from forty-eight to seventy-two hours, and thirty for periods greater than seventy-two hours. (Table I.) Divided according to the method of Munro (1936) into non-operable, operable, and complicated groups, 196 fell into the first, twenty into the second, and eight into the third, with respective mortality rate of 7½, 50, and 25 per cent. There were twenty-seven deaths (12 per cent) for the whole series of 224 cases. (Table II.)

For the thirty patients in whom unconsciousness persisted longer than seventy-two hours the general mortality was 17 per cent. Among these thirty cases twenty-one were non-operable, six operable and three complicated. The mortality rates were 9½, 33, and 33 per cent, respectively. (Table II.)

Of the twenty-seven fatalities 78 per cent died in the first seventy-two hours, eight dying in the first twenty-four hours, nine in the second, and four in the third. Four died after this period but in less than one week, and two after one week. Twenty-two

TABLE II

	Total Cases			Non-operable			Operable			Complicated		
	No.	Deaths	Mort., Per Cent	No.	Deaths	Mort., Per Cent	No.	Deaths	Mort., Per Cent	No.	Deaths	Mort., Per Cent
All cases....	224	27	12	196	15	7½	20	10	50	8	2	25
Cases of pro-longed unconsciousness.....	30	5	17	21	2	9½	6	2	33	3	1	33

Table II. The mortality for 224 cases of cranioerebral injury and the 30 cases of prolonged unconsciousness found among them is shown. They are divided into *non-operable*, *operable*, and *complicated* groups, according to the method of Munro, and the mortality for each group given.

died without ever recovering consciousness, and of these eight died in the first twenty-four hours, seven in the second, two in the third, three after seventy-two hours but in less than one week, and two after one week. (Table III.)

TABLE III

	Deaths without Recovery of Consciousness	Deaths after Recovery of Consciousness	All Cases	
			Deaths	Per Cent
Less than 24 hours..	8	0	8	30
24 to 48 hours.....	7	2	9	33
48 to 72 hours.....	2	2	4	15
72 hours to 1 week..	3	1	4	15
After one week.....	2	0	2	7
Totals.....	22	5	27	;

Table III. The 27 deaths among 224 cases of cranio-cerebral injury are grouped according to whether or not consciousness was regained before death and according to the lapse of time between injury and death.

Two hundred two or 90 per cent of the patients studied regained consciousness eventually, although five of these patients later died. Forty-three patients were still unconscious at the end of twenty-four

hours of whom seven died and three recovered consciousness during the subsequent twenty-four hours. Of the remaining thirty-three who had not regained consciousness after forty-eight hours two were dead and one had recovered consciousness at the end of seventy-two hours, leaving thirty still unconscious. Three of these patients died within the first week and fifteen recovered consciousness, while two of the twelve patients who were unconscious more than one week died and ten recovered. That is to say, twenty-nine or 68 per cent of those patients still unconscious after twenty-four hours, twenty-six or 79 per cent of those still unconscious after forty-eight hours, and twenty-five or 83 per cent of those still unconscious after seventy-two hours eventually recovered. (Table IV.)

The thirty patients in whom unconsciousness was prolonged for greater than seventy-two hours were studied in more detail. Their average age was thirty-two years (twenty-eight for the non-operable, forty-four for the operable, and thirty-seven for the complicated group). The average age of the patients who died was fifty-six (forty-five, sixty-five and sixty-two, respectively) as compared with

TABLE IV

Period	Patients Still Unconscious	Died		Recovered Consciousness				
		During Period		Eventually		During Period		
		No.	Per Cent	No.	Per Cent	No.	Per Cent	
Up to 24 hrs.....	224	8	3½	27	12	173*	78	202* 90
24-48 hours.....	43	7	17	14	32	3	7	29 68
48-72 hours.....	33	2	6	7	21	1	3	26 79
72 hours-1 week.....	30	3	10	5	17	15	50	25 83
After 1 week.....	12	2	17	2	17	10	83	10 83

Table IV. The proportion of patients still unconscious at the beginning of given periods of time who died or recovered consciousness either during that period or subsequently is shown. It should be noted that many of the patients in the first group were unconscious only a few minutes—also that all the patients who recovered consciousness lived except five in the first group, so that the figures for recovery of consciousness also represent survival with this exception.

\* 5 died subsequently.

twenty-seven (twenty-six, thirty-four and twenty-five, respectively) for the patients who survived. It is striking that in each instance the patients who died were twenty to thirty years older on the average

TABLE V

No.	Average Age		Aver-	Aver-	
	Whole Group	Pa-			
	Pa-	Pa-	Hos-	Hos-	
	Pa-	Pa-	Hos-	Hos-	
All cases.....	30	32	27	56	28
Non-operable.....	21	28	26	45	29
Operable.....	6	44	34	65	26
Complicated.....	3	37	25	62	25

Table v. The average age and average hospital stay for the thirty cases of prolonged unconsciousness viewed as a whole and divided into *non-operative*, *operative*, and *complicated* groups are given. The average age of those patients in each group who survived is contrasted with that of those who died.

than those who lived. The average hospital stay was twenty-eight days, twenty-nine for the non-operative, twenty-six for the operative, and twenty-five for the complicated cases. (Table v.)

Twenty-five or 83 per cent of these thirty patients survived; nineteen were non-operative, four operative, and two fell into the group presenting complications. Four of the non-operative patients and one of those with complications had residual

mental symptoms. One each of the non-operative and operative groups had neurological residua. This leaves eighteen or 60 per cent who lived and showed no significant residual changes after prolonged unconsciousness following craniocerebral injury. (Table vi.)

## REMARKS

**General Mortality.** In this series of 224 acute craniocerebral injuries there were twenty-seven deaths, a mortality of 12 per cent. This figure is definitely lower than those given by Dandy (1933), Munro (1934), or Coleman (1931) which were 20, 17 to 20.7 and 18.5 per cent, respectively, but is very close to the figure obtained by Swift and Berens (1938) in a study of 1,433 cases in Washington state with a mortality of 13 per cent. It is suggested that the discrepancy may be accounted for by the fact that in a largely private hospital a greater percentage of patients who were unconscious for a short period of time and who have not been very severely injured are admitted for two to four days' observation and rest, whereas they would be followed in the out-patient department in large municipal or teaching hospitals such as those from which the former statistics are reported. This is further reflected in the much lower incidence of operative and complicated cases as compared with Munro's series. One is inclined to wonder, therefore,

TABLE VI

No.	Living		No Significant Residua		Mental Residua		Neurological Residua		
	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	
All cases.....	30	25	83	18	72	5*	20	2	8
Non-operative.....	21	19	91	14	74	4*	23	1	5
Operable.....	6	4	67	3	75	—	—	1	25
Complicated.....	3	2	67	1	50	1	50		

Table vi. The incidence of survival and of mental and neurological residua for the 30 cases of prolonged unconsciousness is given for the whole number and for those cases falling into the *non-operative*, *operative*, and *complicated* groups considered separately.

\* Two over 50.

if such a group as the one herein reported does not more accurately represent the true mortality in cases of craniocerebral injury viewed as a whole.

*Incidence of Prolonged Unconsciousness.* Patients with head injury in whom unconsciousness persists over a period of days are commonly thought to be quite rare. However, Eden and Turner (1941) have recently reported a series of 200 consecutive cases of head injury among which there were thirty-five patients exhibiting post-traumatic amnesia for days and thirteen patients in whom it went on into weeks. The total constitutes 24 per cent of the cases reported. They measure post-traumatic amnesia from the moment of injury to the first return of consecutive consciousness and this less strict interpretation of the unconscious state plus the fact that some of these patients evidently regained consciousness in less than seventy-two hours would tend to make their figure higher than that reported herein.

In the present series thirty or 13 per cent of 224 patients were unconscious for more than seventy-two hours. Even if this figure is not entirely accurate because of the small number of cases, it does indicate that a definitely significant proportion of craniocerebral injuries fall into this group and justifies the undertaking of this study. It is also noteworthy that the greatest number of patients with acute craniocerebral injury recover consciousness within twenty-four hours (81 per cent of this series) and that few of those remaining unconscious after that period respond within the second or even the third twenty-four hours (6 per cent of these 224), while about twice as many go on to prolonged unconsciousness (13 per cent).

*Mortality in Prolonged Unconsciousness.* It might be thought that after a patient gets through the first seventy-two hours following a head injury without regaining consciousness his chances of recovery would temporarily improve, but tend to decline again when the unconscious state persists for many days. This study bears out the

first of these assumptions but not the second. Reference to Table IV clearly indicates that the incidence of recovery was not as high among patients still unconscious after twenty-four and forty-eight hours (68 and 79 per cent, respectively) as for patients still unconscious after seventy-two hours (83 per cent). However, it was just as high in patients whose unconsciousness went on for more than a week (83 per cent) as in this last group.

It is impossible to draw conclusions as to the exact percentage of each of these groups which may be expected to recover from such a small number of patients, but it does seem fair to conclude that among patients who do not recover consciousness in the first twenty-four hours the prognosis definitely improves if they get through the first three days, even though they are still unconscious at the end of that time. Thus, in this series the mortality rate was 17 per cent for cases of prolonged unconsciousness as compared with 32 and 21 per cent at the end of twenty-four and forty-eight hours.

It is of interest to note that all but one of the five patients who died after a long period of unconsciousness were over fifty years of age, the average age of patients recovering being twenty-seven as compared with fifty-six for those who died. This is in line with the observations of Martin (1937) and Russell (1932) that patients who suffer a head injury after reaching the age of forty or fifty do poorly. This is true in regard to the amount of residual change as well as in regard to the prognosis for survival, as will be shown.

Russell (1932) has also expressed the opinion that the duration of unconsciousness has little to do with prognosis. This does not seem to be true, at least in regard to the outlook for survival. As is shown in Table I, the mortality for patients unconscious less than twenty-four hours was only 7½ per cent and that for the cases of prolonged unconsciousness 17 per cent, while for the patients unconscious twenty-four to forty-eight hours it was 70 per cent and for those unconscious forty-eight to

seventy-two hours it was 67 per cent. This further emphasizes the point previously made that the second and third days constitute the critical period for unconscious patients.

*Prognosis for Complete Recovery.* A surprisingly large proportion of the patients in whom unconsciousness was prolonged for days or weeks recovered without residua. Of the twenty-five who lived eighteen or 72 per cent made such a recovery; this amounts to 60 per cent of the whole group of thirty patients. The percentage was about the same (74 and 75) for the non-operable and operable groups (Table vi), but there were no mental disturbances among the operable cases as compared with four in the non-operable group. One patient presenting complications also had mental residua. It is to be anticipated that some of these five may yet recover, for Martin (1937) has shown that "even when mental symptoms are prolonged their course is towards recovery and in the majority of cases recovery is eventually complete." He goes on to state that most of the patients in whom it does not become complete are over fifty-five. In this view Russell (1932) concurs, saying that "patients above 40 or 50 are much less likely to recover fully." Two of the five cases mentioned are over fifty and one of them has been committed to a mental hospital.

Glaser and Shafer (1932) reported residual neurological signs in 32½ per cent of cases of skull and brain trauma, and an incidence of mental changes of 9 per cent. These figures are practically the reverse of the 20 per cent mental residua and 8 per cent neurological residua found in the cases of prolonged unconsciousness reported herein. The comparison suggests, at least, that in cases of craniocerebral injuries in which loss of consciousness persists for longer than seventy-two hours the proportion of patients who have residual mental changes will be greater, and the proportion of neurological changes less than in ordinary head injury. The obser-

vation again contradicts the opinion of Russell (1932) that the duration of unconsciousness bears little relation to prognosis.

*Treatment.* It is obviously impossible to draw any conclusions with regard to the efficacy of treatment by any given means in a series of thirty cases. Certain broad principles have seemed to make themselves evident in the study of these patients and in the observation and treatment of a number of them, however, which appear to be worth enumerating. In the last analysis they differ little from those principles which most authorities accept as basic in dealing with any head injury.

First of all, as little as possible should be done to the patient. X-rays should be postponed unless there is a question of a depressed fracture. Restlessness may be controlled by sedation but opiates should not be given. An adequate examination is essential but the patient should be disturbed as little as possible. This first principle is in a sense an argument against lumbar punctures, particularly in view of Jefferson's (1932) opinion that compression is not an important factor in unconsciousness and his observation that at operation one is likely to find a low pressure brain with a contused temporal lobe. Furthermore, Zierold (1935) who measured the spinal fluid pressure in 128 cases of severe head injury by lumbar puncture found that "abnormal intracranial pressure is not a frequent occurrence." In 83.6 per cent of his cases the cerebrospinal fluid pressure was less than 180 mm. of water and only in 5.4 per cent did it exceed 300. Bagley, however, emphasizes the value of removing bloody cerebrospinal fluid in cases with associated subarachnoid bleeding (1941).

Secondly, a careful and frequent check of temperature, pulse and respirations, blood pressure and responses should be made and charted. This is extremely important in determining the operability or non-operability of the case. Cerebral decompensation may occur very quickly, and it may be necessary to recognize it at once,

if the patient is to be taken to the operating room in time to save his life.

In the third place, careful attention should be paid to the fluid balance. The urine output is the best guide here. Bladder disturbances are dealt with by instituting drainage, both for the purpose of providing information concerning the output and for the protection of the bladder itself. It seems doubtful whether dehydration methods are of value in cases of prolonged unconsciousness, because of their disturbing effects on the body water in general when used over a period of days and because compression is not usually a factor, as has been mentioned above.

A fourth consideration is supportive treatment and this is of vital importance. Debilitation and infection are two great dangers. Transfusions may be given early for shock, and later to provide protein, and to aid in combatting infection. Tetanus and gas bacillus antitoxins, and chemotherapy should be administered as indicated. Parenteral vitamins should be given from the start and feeding by gavage begun as soon as feasible. Nursing care with special regard to frequent changes in position and attention to the respiratory passages, mouth and skin are of great importance.

These cases differ markedly both as to the underlying pathological condition and as to treatment from those in which the patient regains consciousness and then loses it again, whether rapidly or slowly. The former instance has long been considered pathognomonic of extradural hemorrhage and immediate operation is imperative. The latter suggests a subdural hematoma or hygroma and steps to establish the diagnosis and remove the clot or fluid should be the focus of emphasis. Other complications tending to produce secondary stupor are subarachnoid hemorrhage, brain abscess, intracranial pneumatocele, and rarely depressed fracture and post-traumatic psychosis.

It should be emphasized that any of the above enumerated complications of cranio-

cerebral injury may occur when the state of unconsciousness is due to the magnitude of the brain damage alone and important signs including secondary stupor masked thereby. This again calls attention to the importance of keeping a detailed record of the patient's pulse, respirations, temperature and responses and of making frequent neurological examinations throughout the period of recovery, so that indications for exploration shall not go unnoticed.

#### CASE REPORTS

Certain details in the treatment of patients showing prolonged unconsciousness may be illustrated by the following case records:

**CASE I.** G. S., a white male, aged twenty-four (U.M.H. No. 95815) was brought into the Union Memorial Hospital accident room November 15, 1941, in an unconscious state following an automobile accident. He was said to have called out the name of his companion immediately after the crash and lapsed into unconsciousness. His past and family history was noncontributory, except that it is interesting to note that his father was unconscious seventeen weeks following a head injury and incapacitated two years, but eventually recovered completely.

Examination revealed the temperature to be 98.4° R., pulse 80, respirations 20, blood pressure 118/60. He was a well developed and well nourished white male, deeply unconscious, moving his left side little but thrashed around with the right extremities. The pupils were only pinpoint in size and reacted very little to light; the eyes were roving. The fundi were negative except for left corneal opacity. There was a large bruise about the left eye. There was no bleeding from ears, nose or mouth. Neurological examination showed only some flaccidity of the left side as compared with the right and an equivocal Babinski response on the left. The thorax and abdomen were negative. He was admitted to the hospital for observation.

The pulse stabilized around 90, the temperature around 101° rectally, and the respirations at eighteen to twenty for three days. The state of consciousness continued to be deep coma. The patient received 1,500 cc. of intravenous

fluids daily. Seventy-four hours after the accident the temperature, pulse and respiration fell rapidly within an hour to 99, 60, and

Twelve days after his accident the patient swallowed small amounts of fluid administered by syringe, and on the eighteenth day recov-

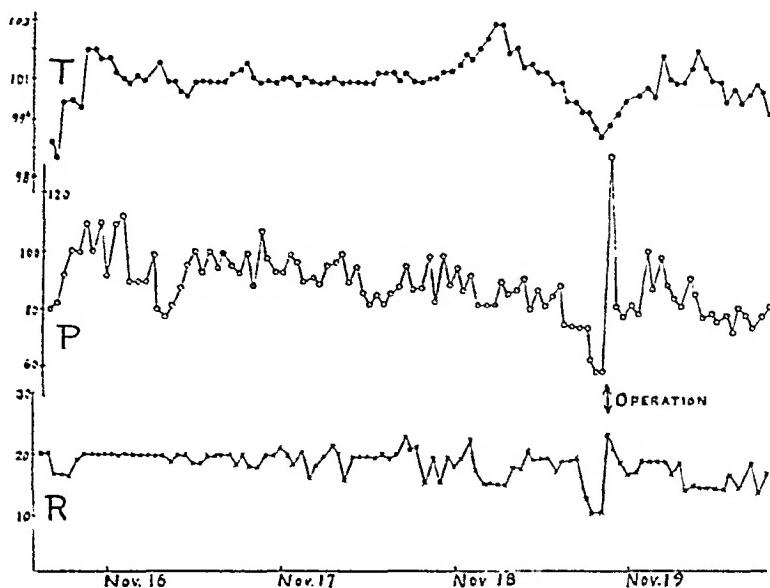


FIG. 1. A chart of the temperature, pulse and respirations in Case 1 during the first five days. The break in compensation near the end of the fourth day and the restoration of compensation following operation is clearly shown.

12, respectively, with periods of apnea. By this time some spasticity of the left side had developed. The patient was taken to the operating room at once and a trephination of the right temporal region done. About 50 cc. of straw-colored fluid under high tension spurted out as soon as the dura was opened; after this about 15 cc. of old blood which had apparently been enclosed in a separate membrane higher over the cortex was evacuated. No cortical damage was seen and the brain pulsated normally after this procedure. A subtemporal decompression was done, two gutta percha drains inserted and the wound closed.

The pulse which had spiked to 160 during the operation but returned to 84 at the end came down gradually over the next thirty-six hours and stabilized in the sixties. The temperature was normal forty-eight hours post-operatively and remained so. The respirations were frequently very slow, sometimes 10 or 12. The cranial wound drained cerebrospinal fluid profusely for six days. Thereafter the decompression wound remained soft and consequently no further operative procedure was done. The patient received intravenous fluids and parenteral vitamins. A transfusion was given on the sixth postoperative day.

ered consciousness as defined in this paper, recognized his wife and called her by name. Three days thereafter he was able to receive an adequate fluid intake by mouth. The left side continued to be paralyzed and it was believed that this must be due to intracerebral damage. Recovery was slow but progressive. There was some mental confusion until shortly before discharge five weeks later. On discharge there was still some memory deficit with a tendency to confabulation and a left hemiplegia.

The patient was followed in the out-patient department. Six months after the accident he was able to walk well and the usual tests of judgment, memory and general information were well performed. The left arm remained paralyzed, but there was good movement from the shoulder and the patient made use of it. No epileptic episodes had occurred.

*Comment.* This case is of particular interest in reference to the recent report of Scott (1942) concerning prolonged stupor produced by subdural hygroma. Since this patient did not recover consciousness following the evacuation of his hygroma, it was evident that some deeper pathological process was at work and this was further

indicated by the persisting paralysis. The process is believed to be intracerebral in nature. One of Scott's patients (II) was

out on supra-orbital pressure. Abrasions and hematoma of the left side of the head were present. Both pupils were small, the right

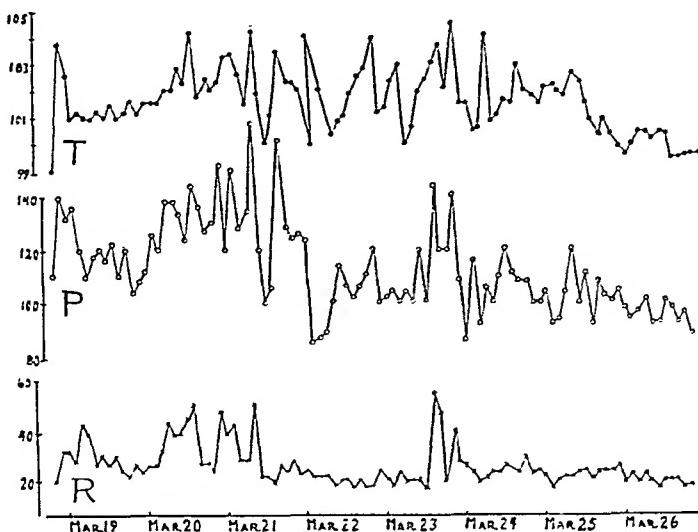


FIG. 2. A chart of the temperature, pulse and respiration in Case III during the nine days following injury. The precarious state of the child is obvious from the wide fluctuations, and the final establishment of cerebral compensation on conservative treatment alone is evident.

unconscious a total of twenty-nine days and accordingly falls into the group of cases with which this study is concerned. The other two regained consciousness following head injuries to become stuporous again later and fall into what must be considered definitely an operable group.

A chart of the temperature, pulse and respirations in Case I is shown in Figure 1. The first five days are shown and the chart illustrates the suddenness of onset of cerebral decompensation and emphasizes the importance of careful and frequent recording of the vital signs.

**CASE II.** M. J. G., a white male of five years, (U.M.H. No. 83301) was brought to the Union Memorial Hospital accident room September 7, 1940, shortly after he had been struck by an automobile. He had been picked up unconscious and arrived at the hospital in this condition.

Examination showed a temperature of  $100.4^{\circ}\text{R}.$ , pulse 90, respirations 26, blood pressure  $132/80$ . He was a well developed and well nourished child in coma. He moved and cried

more so than the left, but they reacted well to light. There was no bleeding from the ears, nose or throat. The neck was slightly stiff but the thorax and abdomen were negative. The neurological examination showed some flaccidity on the left side, but the reflexes were everywhere equal and active, except for absence of the abdominal reflexes. There was bilateral unsustained ankle clonus and no Babinski. There were no other positive findings.

For the first twenty-four hours the pulse was 130 to 140 and the temperature 101 to  $102^{\circ}$  rectally. The child was deeply comatose most of the time, but occasionally would cry out irrationally when disturbed. By the third day the pulse and temperature were nearly down to normal and the child opened his eyes but did not respond. The patient's general condition improved over the next three days, and by the sixth day had begun to move the left side a little, the leg more than the arm. On that day the patient spoke a few times. "I want some milk." "Give me a cracker." Thereafter the child appeared alert, but was very irritable and unstable. By the end of another week he was using the left side better and was able to stand. On discharge on the sixteenth day after

injury his mental state was clear and there was minimal difficulty in the use of the left arm and leg.

**Comment.** This is a case in which some neurological residua were present despite a relatively short prolongation of unconsciousness. It may be contrasted with Case III in which the period of unconsciousness was four times as long with minimal residua.

It is this type of case that makes it necessary to be particularly guarded with regard to prognosis. Prolongation of unconsciousness is, of course, in itself an indication of severe disruption of cerebral function, and while the study reported here shows that the outcome is often much better than one would hope, a fair percentage of the patients still have residua.

**CASE III.** R. H., a white male, aged three years, (U.M.H. No. 98443) was brought to the accident room of the Union Memorial Hospital on March 18, 1942. He was said to have run into a moving car fifteen minutes earlier and to have been unconscious when picked up. No convulsions or bleeding about the head had been observed.

Examination revealed the temperature to be 98.8°<sup>R.</sup>, pulse 108, respirations 20, blood pressure 90/60. He was a well developed and well nourished child deeply unconscious. Respirations were deep and somewhat irregular and his color was good. There were several abrasions of the legs but no lacerations or hematoma about the head and no gross skull injury. The eyes moved aimlessly; the pupils both reacted well to light; the right pupil was slightly smaller than the left. Fundi were negative. There was no bleeding from the ears, nose or mouth and the thorax and abdomen were negative. Neurological examination showed all extremities to be slightly spastic with hyperactive reflexes and positive Babinski and Oppenheim signs bilaterally. Bilateral ankle clonus was also noted, but no Hoffman. Abdominal and cremasteric reflexes were absent. A slight writhing of the body was observed on supra-orbital pressure. The patient was incontinent of urine.

The child was admitted to the hospital three-quarters of an hour after the accident. On admission the temperature was 99° rectally

and the pulse 110. Ten hours later both had gone sharply upward—to 103.8° and 140, respectively. During the next twenty-four hours the child was more restless and seemed to move the right side slightly better than the left. There was no change in the state of consciousness or the reflex picture. The pupils were now equal.

During the next five days the boy's temperature spiked to 103° or over twelve times. Each time it fell about two degrees after sponging. The pulse and respirations followed the temperature, the former ranging from 84 to 170 and the latter from 20 to 48. (Fig. 2.) Thereafter the temperature remained slightly elevated most of the time, but did not go over 102° rectally. The pulse stabilized at 80 to 120 and the respirations at 20 to 24. The temperature was normal after twenty-seven hospital days and the pulse 90 to 100.

The child was given intravenous fluids until the thirteenth day when feeding by gavage was begun. Parenteral vitamins were given until administration by mouth was possible. X-rays on the fifteenth day showed no fracture and a diagnostic lumbar puncture on the seventeenth day revealed clear, colorless fluid under a pressure of 90 mm. of water—Pandy negative, no cells.

On the sixteenth day the patient would follow objects with his eyes and grasp the observer's finger with the right hand, although he moved the left side little. On the twenty-sixth day he was able to take liquids by mouth and was moving the left side as much as the right. By the thirty-fourth day he could pull himself into a sitting position, speak, recognize persons, drink out of a glass and eat with a spoon. Two days later he was walking with a somewhat spastic gait. Five days later he called a visitor by name and asked for the urinal.

The child was given physiotherapy and had a good return of muscular function. He was discharged well after sixty-five days in the hospital. On discharge there was a minimal weakness detectable on examination on the left side, but this was not noticeable in the boy's activity. The reflexes were active; none were abnormal and there was no clonus. The cremasteric and abdominal reflexes were present. The mental state was clear and the intelligence appeared normal for a child of three.

**Comment.** This case is remarkable for the obviously terribly severe nature of the cerebral injury as compared with the completeness of recovery. It may readily be contrasted with Case 11 in this respect. The result in this case is attributed to the fact that therapy was ultraconservative and that no added insult was superimposed on the original brain damage. In the first desperate days when the patient swung many times out of the range of cerebral compensation, the temptation to perform operative exploration was strong, but it seems reasonable to suppose that any such attempt would have resulted in the depletion of the child's feeble reserves and death.

The question may be raised whether bilateral taps might not have hastened recovery. In answer to this it can only be said that at no time did there seem to be a definite indication for operation when the child seemed at all likely to survive the simplest procedure. In fact, as late as the fifteenth day when skull x-rays were taken—and this was done with considerable circumspection—the condition of the patient was affected very adversely and it was feared for a period of hours that he was going to die.

It was just as important to recognize the non-operability of this case as the operability in Case 1. These histories serve to emphasize the fact that there is no substitute for careful, continual observation of the unconscious neurosurgical patient.

**CASE IV.** L. B., a white male, aged sixty-two years, (U.M.H. 87083) and a fire chief by profession, was brought to the Union Memorial Hospital accident room in an unconscious state. He had suffered a head injury in an automobile accident. He was bleeding about the head when picked up and draining clear fluid from both ears.

His temperature was 97.4° R., pulse 90, respirations 26, blood pressure 160/90. The patient was a well preserved male of sixty-two years. There were lacerations of the forehead and drainage from both ears which was obviously cerebrospinal fluid. There was no blood or fluid from nose or mouth, no evidence

of depressed fracture. The pupils were equal and reacted to light, but the eyes moved aimlessly. Fundi were negative. The heart was not remarkable. Both lung fields were resonant, but many coarse rales and rhonchi were heard. There was mucus in the throat; the abdomen was negative but there were no positive findings on neurological examination.

The patient's course was satisfactory for ten days although he remained unconscious. At times there was respiratory embarrassment when the respiratory rate would be as high as 40. The temperature ranged between 101 and 102°. A lumbar puncture on the ninth day showed xanthochromic fluid under a pressure of 205 mm. of water. The patient did not rouse from coma, although he was restless at times.

On the eleventh day a massive collapse of the left lung occurred. Bronchoscopy was performed and a mucous plug removed. The next day, however, a second massive collapse of the same lung occurred. Treatment was unavailing this time and the patient died twelve minutes after the collapse occurred.

**Comment.** This case is presented as an example of a "complicated" craniocerebral injury in which unconsciousness was prolonged and in which death occurred. The death, however, is obviously to be attributed to the complication rather than the actual injury to the head, although the severe nature of that injury was evident from the presence of cerebrospinal otorrhea. The importance of skilled nursing care in cases such as this cannot be overemphasized. Careful attention to frequent changes in position and keeping the respiratory passages clear by means of suction is imperative.

The four case histories given in detail have served to illustrate the types of problems which arise when a craniocerebral injury is followed by prolonged unconsciousness and to emphasize certain points in regard to the care of these patients. The outcome in three out of four of these patients and in the great proportion of these thirty cases of head injury in which unconsciousness was prolonged shows that unsparing effort in the care of such patients is well worth while.

## SUMMARY AND CONCLUSIONS

1. Two hundred twenty-four cases of craniocerebral injury have been studied and among these there were thirty cases in which unconsciousness was prolonged. The mortality was 12 per cent for the whole group and 17 per cent for the cases in which unconsciousness persisted for more than three days.

2. When an unconscious patient has survived the first critical seventy-two hours following craniocerebral injury, the prognosis both for survival and for recovery with little or no residua is good—83 per cent for survival according to this series with 72 per cent of those living making a complete recovery.

3. Treatment in these cases should be conservative, providing adequate fluid and nutritional supply. Care should be taken to ward off infection either intracranial or general. Operative intervention should not be undertaken on the basis of prolonged unconsciousness alone.

4. Persisting unconsciousness may mask the presence of such complications as extradural or subdural hemorrhage, brain abscess, etc. A careful record of the temperature, pulse, respirations and blood pressure plus frequent neurological examinations will reveal the presence of these in adequate time for the institution of operative treatment.

5. Cases in which consciousness is regained and is lost again do not belong in this group; such patients are candidates for immediate surgical exploration.

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# PATHOGENESIS AND EXPERIMENTAL THERAPY OF KELOIDS AND SIMILAR NEOPLASMS IN RELATION TO TISSUE FLUID DISTURBANCES

WALLACE MARSHALL, M.D.

AND

SAMUEL ROSENTHAL, M.D.

Medical Consultant, White Male Service, City Hospital  
MOBILE, ALABAMA

Diplomate of the American Board of Internal Medicine  
MILWAUKEE, WISCONSIN

**I**T is the purpose of this communication to review the known facts on the pathogenesis of keloids, and related clinical entities, in view of recent observations which have been collected by the authors.

The presence of such new growths is most discouraging to both the patient and surgeon, for the disfigurement which such a process produces is a matter which imposes delicate judgment in respect to therapy. Christopher<sup>1</sup> has written that "Scars are produced in the process of healing of tissue injuries and result in deformities which may be unsightly if visible. When disfiguring, they may cause mental distress and influence the activities of the bearer . . . Should there be a combination of trauma and disease, the resultant deformity will be greater."

Marshall<sup>2</sup> has summarized the psychological upsets which have been produced by the disfigurement of acne, and these findings are similar in nature to those which are found in patients with visible keloid growths. The keloid is indeed more vicious, for the sufferer may be well aware of the therapeutic shortcomings of the many measures now employed in this disfiguring lesion.

## ORIGIN OF PRESENT STUDY

Marshall<sup>3</sup> has recorded some observations with the use of a special material made from liver extract which has improved cases of acne vulgaris. In this study, he observed that various scars produced by acne seemed to disappear partially through a partial absorption phenomenon. He was able to demonstrate this action on the basis of a vasoconstricting substance

which he believed was present in his experimental fractions which were prepared from liver extract. The unusual physiological action of his preparations led him to the belief that scars and other allied processes may be at least semireversible. In other words, in skin areas which exhibited a venestasis, the vasoconstricting principle improved these areas by partially checking the outflow of fluid from the dilated blood vessels. He observed, further, that as these areas became whiter in color because of the vasoconstricting action of this material, which was injected subcutaneously about twice a week, the size of the hypertrophic scars was lessened to a marked degree.

In order to apply these findings on vasoconstriction to wound-healing, he found that wounds improved in healing by vasoconstriction which was produced by the application of ice compresses to the surgical site. Among the applications of other principles, which are of importance in wound-healing, was the matter of asepsis and the use of adequate doses of vitamin C,<sup>4</sup> which seemed to assist in the formation of a scar of strong tensile strength and the adequate healing of the tissue injury without hypertrophic changes.

While this observer was engaged in this research, he had the occasion to study the effects of his experimental vasoconstricting material on patients with keloids and hypertrophic scars.

Since these observations appear to be of importance in our present concepts of the pathogenesis of keloid formation, it is our wish to review the basic mechanisms which seem to be intimately connected with such a process.

Yates and Raine<sup>5</sup> have published an excellent review of the functions and the diseases of the lymphatic system.

#### NATURE OF KEOLOIDS AND RELATED ENTITIES

A keloid is a non-inflammatory fibroma.<sup>6</sup> The keloid differs from the hypertrophic scar since it involves skin areas beyond the limits of injury.<sup>7</sup> Hypertrophic scars contain small collagen fibrils while keloids are composed of large collagen fibrils.<sup>8</sup>

Hypertrophic scars, keloids, the nodulus cutaneum of Arning and Lewandowsky, and induratio penis plastica, are included under the group of hard fibromas, according to McCarthy.<sup>9</sup>

The nodular subepidermal fibrosis of Michelson, or the fibroma simplex, according to Becker and Obermayer,<sup>10</sup> consists of slightly elevated and firm nodules which may be noted on the thighs or legs, trunk, or even the arms. They may appear singly, but they may be multiple and are not grouped. Their color is, at first, rather erythematous, brownish later on, after which they appear elevated or depressed due to regression. They retain their firm nodular character. Becker and Obermayer have described these neoplasms as subacute or chronic inflammations which are accompanied or are followed by fibrosis. They have written that the tissue is highly cellular at first, but this tends to become more fibrotic later on. The infiltrate blends imperceptibly into the adjacent normal connective tissue and the lesion is not encapsulated as is the fibroma durum.

According to Christopher,<sup>11</sup> scars are composed mostly of connective tissue with a thin epithelial covering. Sweat and sebaceous glands are absent usually, and this loss apparently affects the normal skin lubrication. The connective tissue fibers in scar tissue are more dense and less elastic than are the connective tissue fibers of normal skin.

Christopher has written that the factors which produce hypertrophic scars are not fully understood, for some individuals have

a tendency to develop them while others do not. Keloids, when excised, almost always have the tendency to recur.

Similarly, the cause or causes of keloid formation are not definitely known. Becker and Obermayer believe that a definite predisposition to their formation must be assumed. There is evidence which points to a familial tendency in this disorder. A recent communication by Garb and Stone<sup>12</sup> postulates a hormonal disturbance, the nature of which is unknown.

From the microscopic aspects, keloids are composed of quite cellular fibrous tissue, and these fibers cross in several directions, parallel to the surface. Becker and Obermayer have made a definite point by stating that, as the keloid progresses, the cellular elements diminish and the neoplasm is composed chiefly of collagen bundles. Rarely does spontaneous regression take place and the possibility of malignant degeneration must be kept in mind.

In other words, when a wound heals normally there is a cessation of fibrous tissue formation as soon as continuity is re-established. However, this is not the case in keloid formation, for here the proliferation of fibroblasts continues with "piling up," as it were, of fibroblasts. This results in the formation of the new growth which is called a keloid, and which is a firm, fibrous, non-elastic connective tissue proliferation. Bundles of coarse, large connective fibers intertwine in all directions.

Becker and Obermayer<sup>13</sup> have described the keloid as "at first erythematous, smooth, with an appearance of tenseness of the superficial epithelium and telangiectasis over the surface." Keloids often project peripherally in the form of one of several "feet" which extend into normal tissue. The character of the keloid depends somewhat on the extent of initial injury. These lesions usually grow to a certain size and then remain stationary. As the keloid grows older, it becomes very firm, less erythematous, and eventually may be flesh-colored or paler than the surrounding

skin. The so-called "spontaneous keloids," i.e., lesions which arise without demonstrable previous injury, are usually located in the sternal area of the chest. It may be assumed that microscopic injury gave rise to their growth just as keloid formation follows follicular pyogenic infection in predisposed individuals (acne keloid). Keloid is much more frequent in the Negro. It often occurs following burns, either chemical or caloric. Strangely enough, not all injuries in a susceptible individual are followed by keloid formation. Huge keloids have developed after piercing ear lobes for ear rings, while accidental cuts or other injuries in the same person have resulted in ordinary scars. This is probably the result of variation in the local response in the same individual.

McCarthy<sup>14</sup> has described three types of keloids: The first type is "the spontaneous or true keloid" which arises without any trace of injury or infection and occurs symmetrically on the chest in the form of whitish plaques or flat nodules, which by the formation of peripheral fibrous strands, seem to merge gradually into the surrounding skin. The second type is "the false or scar keloid" which results from injury as does the hypertrophic keloid, the third type, which it resembles. The scar keloid proliferates and extends laterally beyond the limits of the original lesion, while the hypertrophic keloid grows in an upward direction, producing, as the name indicates, a tumor that projects above the normal skin level. Histologically, the papillae may be involved secondarily, but the keloid always begins in the cutis or subcutis and never in the papillae. As it grows upward, the papillae are involved and, therefore, there is no histologic basis for separating the true from the false keloid. Young keloids are different in appearance than older ones.

In young keloids, unless recently injured, the epidermis and the papillae are normal. If the keloid is deep in the skin, the cuticular appendages are untouched. The tumor mass is made up of young connec-

tive tissue extraordinarily rich in cellular elements. The connective tissue bundles are not easy to make out. The cellular elements have a tendency to group themselves in certain regions in the form of ill-formed whorls which Warren, Unna and Joseph thought resembled vascular periadventitia and were probably the points of origin of the keloid. The cells have long oval bodies with large vesicular nuclei which show numerous regular mitotic figures.

As the keloid ages, the collagenous fibers appear and connective tissue bundle formation takes place at the expense of the cellular elements which are gradually compressed and progressively diminish in number.

With Weigert's lithium-carmine stain, we see that the tumor is made up of coarse, intertwining tissue fibers which are poor in cellular elements and sharply limited from the surrounding normal tissue. The tumor mass is, as a rule, entirely free from elastic fibers, and it offers a sharp contrast to the surrounding skin with its normal elastic fiber content. In others, a few fine shredded fibers can be made out. Above the tumor and separating it from a normal epithelium is a narrow zone of normal supporting tissue.

In the end stage this hard fibrosed tumor mass appears to be enclosed in a capsule not of its own making but rather due to the compression of the immediately surrounding normal connective tissue (pseudocapsule). Mucoid degeneration (pale red with polychrome methylene blue stain) can be made out in some of the fibers of this pseudocapsule. As a spontaneous keloid continues to grow, it extends in all directions and eventually destroys the papillae and presses upon the overlying epithelium which shows signs of a general thinning and an atrophy of the individual cells. At this stage the true keloid presents no histological differences from the false keloids. It is evident that as the false or scar keloids arise secondary to the previous disturbance (trauma or infection), the papillae have already been destroyed and

the keloid may arise in any layer of the skin, depending upon the depth of the previous injury or infection.

#### PHYSIOLOGICAL PRINCIPLES WHICH ARE INVOLVED

In order to understand what factors govern the normal flow of the tissue fluids, and what possibly may happen to this delicate mechanism when such neoplasms as keloids and hypertrophic scars develop, a review of the basic physiological principles will be undertaken at this time.

*The Nature of Tissue Fluid.* According to Best and Taylor,<sup>15</sup> water makes up approximately 70 per cent of the body's weight and extracellular fluids account for about 20 per cent, while the skin contains about one-fifth of the total water in the body. These investigators have stated that this body water is practically all in the free state, since substances can be dissolved in it and they can also be removed from the body water by ultrafiltration. Colloids and other chemical constituents actually bind very little water. The concentration of potassium in the interstitial fluids and the blood is only a small fraction of the sodium concentration, while in the tissue fluids, the concentration of sodium is much less than that of potassium.

The body tissue fluid including the intracellular skin fluid, is composed of serum globulin, fibrinogen, and serum albumin, while elastin and collagen, which enter into the formation of protective and connective tissues, are classified as albuminoids. Collagen enters into the formation of actual connective tissue, while elastin is used in the synthesis of elastic tissue.

*The Mechanisms of Tissue Fluid Exchange.* There are two factors which influence this interchange between blood vessels and the tissues: (1) Osmotic pressure: This is the drawing force which certain solutions have on the body solution (tissue fluid) when separated by a semi-permeable membrane. This osmotic pressure is, in turn, governed by certain physical laws. (2) Hydrostatic pressure:

This is the actual pressure within the capillaries which has been produced by the force of the heart's pumping action, the blood pressure, and its relation to that of the extravascular tissue fluids.

As has been mentioned, the following plasma proteins are in solution: albumin, globulin, and fibrinogen. Since albumin has the smallest molecule, it escapes more freely than do the others.

Best and Taylor<sup>16</sup> have recorded that "the osmotic pressure of the plasma, if anything, increases as the blood passes along the capillary as a result of the passage of water outwards, and the consequent rise in the concentration of the protein. That is, the force holding fluid within the vessel is increased. The hydrostatic pressure, on the other hand, falls gradually from the arterial to the venous end of the capillary. Near the arterial end the blood pressure is greater than the osmotic pressure and a filtration of fluid of low protein content will result. Near the venous end the hydrostatic pressure may fall below the osmotic pressure and a flow of dilute fluid (water and salts) from the tissue spaces into the blood will be brought about. Transudation of a dilute plasma and re-absorption of a saline fluid, respectively, are continually going on in these two regions of the capillary bed. Metabolic processes in the tissues bring about changes whereby larger molecules are being broken down into smaller ones; other molecules are removed or built up into larger ones. In this way, alterations in molecular concentrations and in the diffusibility of the constituents of the tissue fluids with consequent variations in osmotic relationships are occurring ceaselessly. Under any circumstances in which the blood volume is increased or diminished, either the hydrostatic pressure or the osmotic pressure or both are altered, and it is through such changes that the blood fluid is restored automatically to its previous level."

*Lymph Formation and Circulation.* The forces which control the regulation of the

tissue fluids are concerned directly in the formation of lymph, since these two processes are interrelated and quite similar, with the exception that the protein portion of the fluid passes into the lymph channels where it is returned to the body economy through the blood stream. The lymph also has the ability to absorb other colloids.

Capillary filtration is directly proportional to the increase in venous pressure, for extracapillary pressure is followed by a fall in the filtration rate, because of the fluid accumulation which opposes the hydrostatic pressure in the capillary system.

Increase in the permeability of the capillary wall is produced by: (1) Rise in temperature, which increases the lymph flow and the filtration rate; (2) reduced oxygen supply (anoxia) through damage to the capillary endothelium. An increase in the flow of lymph is produced by: (1) The formation of metabolites which increase the osmotic pressure of tissue fluids and thus pull in more fluids from the tissues; (2) vasodilatation and the increased capillary pressure. Similarly then, a decrease in the metabolites in tissue fluids, or vasoconstriction, with a decrease in capillary pressure, will retard the flow of lymph or tissue fluids.

Some of the major causes for the production of tissue edema can be effected through the reduction of the osmotic pressure of plasma, the general or localized changes which can be produced in capillary blood pressure, the increased permeability of the capillary membrane, obstruction of the lymph drainage channels, the mechanical obstruction of veins, or from edema due to cardiac decompensation, from renal disease itself, or from the ravages of tissue infection.

*The Unusual Anatomy of the Skin Vessels.* Becker and Obermayer<sup>17</sup> have adequately summarized this feature in stating that "small arteries supply the superficial portion of the body. The course of the artery is through a cone-shaped area with its base at the surface and its apex in the subcutaneous tissue. The vessel

divides time and again, unites itself in at least two anastomotic plexuses and terminates in capillaries in the papillae. From there, the blood enters small veins which unite with other venous tributaries to produce another cone-shaped system. The junctions of the bases of these cones form the network seen in cutis marmorata and certain other vascular conditions. The same artery supplies blood via capillaries to the tissues making up the dermis, and to the glands contained therein. The venous drainage is similar. The lymphatic drainage of the skin is through tissue spaces originating between the cells of the prickle-cell layer, thence into the dermis, in the middle portion of which are the first lymph channels. These anastomose and unite with other channels and to course with the blood vessels and nerves through the subdermis as tributaries to the larger lymphatics in the deeper tissues."

#### LOCAL EFFECT OF EXCESSIVE LYMPH OR TISSUE FLUIDS IN VARIOUS<sup>1</sup> DISEASES

Ordinarily, lymph stasis produces edema and the tissue spaces are engorged by any one or more of the causes which have been described heretofore. Because of its low fibrinogen content, lymph, or tissue fluid, will not tend to coagulation.

However, the influx of lymph or tissue fluid, which produces an enlargement of the lymph spaces, will stimulate the production of fibrous (connective tissue) tissue in the involved area.<sup>18</sup>

Perhaps a short summary of such a phenomenon, in the course of several diseases, may demonstrate the tendency of the stimulus, for the formation of fibrous tissue, when a lymphatic transudate of fluid is present.

In cases of filariasis, the venous return and the lymph exits are blocked by the Filaria bancrofti, and early cases exhibit a large amount of coagulable fluid from the lymph spaces and the connective tissue. This gives the impression, on examining such tissues microscopically, that the tissues are injected with gelatin.

As the disease progresses, definite fibrous connective tissue is formed in the dilated lymph spaces and channels. Progressive local hypertrophy is a clinical characteristic of this disease. Even the skin in these cases shows an edema with a resultant hyperplasia of the connective tissue of the skin itself, as well as the subcutaneous tissues.

This extravasation of tissue fluid is noted also in other portions of the body in various diseases. This transudate is usually straw-colored or it may be colorless. Of particular interest is the fact that fibrinogen is present along with the serum albumin and the globulin fractions. Peculiarly enough, the presence of fibrin is rather rare. The endothelial cells of the lymph spaces may be present along with some red and white blood cells. However, this transudate contains most of the known materials which can respond to cellular injury and may thus initiate the formation of connective tissue.

As is the case with the cellular spaces in the skin, such a transudate may push the tissue cells apart, and if this process continues, fibroblastic growth may be initiated. Since identical processes can occur in other parts of the body, such transuded fluid in the interstices of the tissues is termed an *edema*. If it happens to occur in serous cavities, the extravasation is called *dropsy*. Its presence in the pleural cavity is termed *hydrothorax*, and in the heart lining (pericardium) it is *hydropericardium*. Other similar transudates are the hydrocele, hydroperitoneum, etc. Hence, the thickening or hypertrophy of such structures is usually preceded by the presence of a serous extravasation with subsequent formation of fibroblastic (connective) tissue.

Therefore, such disorders as anasarca, trichiniasis, syphilitic tarsitis, myxedema (especially the thickening of the eyelids), Mikulicz's disease, Milroy's disease, chronic lymphatic obstruction, acromegaly, myositis, anthrax, pleurisy with effusion, fibrinous pericarditis, also certain forms of

arthritis, all have shown, at one time or other, the presence of a serous transudate which was produced by various pathological processes. In many cases, the excessive lymph, or tissue fluids, had been followed by the formation of connective tissue as a defensive or compensatory measure. This effect is, perhaps, more intensified when infection, or the addition of foreign bodies, are added to the effect of excessive lymph or tissue fluid.

#### PATHOGENESIS OF KEOLOIDS AND RELATED ENTITIES

Geschickter and Lewis<sup>19</sup> have written about hereditary and congenital predisposition as definite factors in keloid growth. Calcium metabolism and a localized endocrine disturbance were thought responsible.

Nason<sup>20</sup> states that trauma is always the etiologic precipitating factor in the production of keloids. There is a certain "fibroblastic diathesis" which varies in intensity among races and individuals.

Filips<sup>21</sup> believes that the underlying cause of keloid formation is the hypersensitivity of the fibroblast and the vascular endothelial cells to any agent having the power to mobilize those elements in the protein of these cells which induce them to proliferate.

Drinker and Field<sup>22</sup> have produced experimental edema in dogs by injecting the lymphatics with silica. They quote Manson who did not believe uncomplicated lymphatic obstruction could cause elephantiasis, since infection must be present also. This lymph blockage shows that the fibroblasts are the first cells to grow. This is true in tissue cultures and these authors believe that it is also true in the body when a medium is present which is rich in blood protein and the products of cell destruction. Venous obstruction produces the same situation and the tissue fluid, under such circumstances, is not far different from that of inflammation and, hence, the environment for fibrous overgrowth is simply provided in a more ideal form than can be

the case with uncomplicated block of the lymphatics.

Bearing these observations in mind, we can return to the matter of keloid formation. In the skin there are multiple strata which are composed of various types of skin cells, and the tissue spaces are readily accessible to any extravasation of excess tissue fluids which might be produced by an increase in capillary pressure. The dilatation of the blood supply occurs with a slowing of the blood stream in such a case. Hence, lymphatic drainage may be obstructed, so that the transudate of lymph material escapes from the vessels. The edema is rather localized to an area of varying size which involves the site where lymph is present in excessive quantity.

Since it has been shown that early keloids and hypertrophic scars show the presence of a collagenous material, microscopically, it may be assumed that this collagen is closely related to the edematous material which precedes the formation of connective tissue. The connective tissue proliferation develops as the keloid grows older, and the serous material is never completely absorbed, but connective tissue continues to develop until a partial quiescence occurs.

The clinical appearance of the keloid coincides with scopic changes, for the keloid is soft to the touch in its early stage, but becomes firmer to the touch as connective tissue is developed.

Thus, it is the localized edema, followed by the laying down of connective tissue, which causes pressure to be exerted in the tissue spaces. This pressure is directed upward, since the force of least resistance is at the surface. Atrophy of the epithelial skin covering takes place and this results in the so-called pseudocapsule to which the pathologists have referred.

As this process develops, with the involvement of adjacent areas of the skin, the size of the neoplasm increases and its growth and extension of contiguous skin tissue ceases only when the surrounding tissues can compensate for the disturbed

flow and stops in the tissue fluids present in the keloid.

The "trigger" mechanism in keloid formation appears to be similar, therefore, to the phenomenon of diapedesis which causes some individuals to bruise so easily or to develop idiopathic purpuric spots. In the case of keloid growth, it is the extravasation of lymph, while in the other, it is the loss of blood through the vessel walls because of their lowered permeability.

It is known that much serum escapes from third degree burns. That is why multiple plasma transfusions have been indicated for the shock which such a condition produces. This is due, in part, to the escape of fluid from the vessels into the tissue space.

Furthermore, third degree burns are known to produce keloid formation readily. It is logical to assume that this formation of excess fibrous growth may be due, in part, to the great amount of serous exudation which seeps from the wound area. If this transudate remains stagnant in the burned tissues for some time, an excessive amount of connective tissue is liable to occur in the clinical form of keloids or hypertrophic scars.

If a clean-cut incision with a razor sharp instrument is made without the introduction of pathogenic bacteria, the keloid growth is not liable to result, for there is not the excess transudation of tissue fluids in the wound area. Furthermore, because of the close proximity of the tissues in such an incision, there is little space for transudate to collect and remain stagnant. For these reasons, such a wound will heal rapidly without keloid formation. This is especially true if the vitamin C intake is adequate and the circulation in the wound area is kept at a low temperature by ice packs.<sup>23</sup>

#### SUPPORTIVE EXPERIMENTS ON PATIENTS WITH KEOLOIDS

As has been mentioned before, evidence has been collected to show that scars, *per se*, are not entirely permanent,<sup>24</sup> for there

seems to be at least some permanent reduction in the size of the scar tissue when the vasoconstrictor material was employed parenterally over a long period of time. (The vasoconstricting material is a special fraction of liver extract prepared by the Eli Lilly Laboratories of Indianapolis according to Marshall's technic.) The reduction in the size of the keloid could be noted within fifteen minutes if the vasoconstricting substance was injected intradermally in the immediate proximity of the keloid. No intrakeloidal injections were used as it was believed that the collagenous material would plug the fine needle. Following injections into the skin, fine white linear streaks from 1 mm. to 5 mm. in length and from 1 mm. to 2 mm. in width could be seen with a radius of 15 to 20 cm. of the site of injection denoting vasoconstriction of skin capillaries. This material appears to have a selective vasoconstricting effect on the skin capillaries since no constitutional effects such as increased blood pressure or tachycardia have been seen following either subcutaneous or intradermal injections. In this respect, it differs markedly from the action of adrenalin or ephedrine.

Since the clinical and microscopic studies have demonstrated the presence of a relatively abundant amount of tissue fluid present in hypertrophic scars and keloids, this experimental work has shown several points of interest. It has been shown, for example, that vasoconstriction of the terminal blood vessels of the skin tends to remove the stains which accompany infection with the resultant keloid formation. Our studies have shown that the induration, and hyperemia, tend to improve when the vasoconstrictor material reaches the involved skin areas. Hence, the blanching effect of this material is the result of the vasoconstricting action from our experimental material.

By parenteral injection this therapeutic effect is generalized, in that by absorption the material reaches such areas as the back, chest, face, and arms of the patients. Five

patients who have had weekly parenteral injections over a period of one and one-half years, have presented a decided clinical improvement of the keloidal areas.

The question arose as to the advisability of injecting this vasoconstrictor material directly into the scar tissue, since it was reasoned that the therapeutic effect may be greater by implanting the material directly into the keloids and hypertrophic scars.

It happened that a new case became available for such an experiment. This young man had two large, separate keloids at the inferior portion of the left mandibular region. He had, also, the typical "washboard" keloids as the result of acne vulgaris some years ago. He had been given nine subcutaneous injections of  $\frac{1}{20}$  cc. of our experimental fraction which was derived from liver extract. The therapeutic periods were spaced at weekly intervals. During these nine weeks, the mandibular keloids had "shrunk" about one-half an inch in length and about one-fourth inch in width. They were softer in consistency and had become somewhat blanched, for previously they were markedly hyperemic. The sternal keloids in this case exhibited identical changes.

Several direct injections were performed on the upper mandibular keloid, which was the larger neoplasm. No injections were made on the lower mandibular keloid. These treatments were performed at weekly intervals.

As each injection of the upper keloid was performed, it was noted that the hypodermic needle (Becton-Dickinson No. 26 gauge) met with definite resistance because of the resistance which was caused by the apparent fibrotic keloid mass. One-twentieth cc. of our experimental fraction was injected with considerable difficulty, and care was taken not to push the needle into the tissue below the neoplasm.

Due to the trauma, which was caused by this injection, the keloid became markedly hyperemic and this was present for about three minutes, after which time, the neo-

plasm was noted to blanch. This was rather marked in extent after five minutes following the time of injection. The inferior keloid did not show the preliminary hyperemia, but it began to blanch in about the same time.

It was observed that the borders showed a marked blanching, and furthermore, as time progressed, these borders seemed to lose their fluid content to some degree. This was tested by using a pencil point for such palpation, which produced a definite pitting phenomenon which was not evident before the injection was administered.

There was an escape of straw-colored fluid at the site of the injection area. In order to determine whether this exudate was our injected material or escaping tissue fluid, this exudate was placed in capillary tubes which were broken at minute intervals to determine the presence, if any, of a clotting phenomenon. We noted its occurrence in five minutes. Evidently, this escaping fluid was "tissue juice," for it showed the presence of a "fibrin veil."

As time progressed, both keloids showed a definite flattening of their borders, so that the skin follicles with their protruding hairs were discernable. These were not present before the injection. Furthermore, a marked multiple "creasing" effect occurred in the dome of the keloids as the pressure of the fluid escaped or was partially absorbed through the vasoconstricting action of the injected experimental material. The escape of the tissue fluid through the puncture wound was very small in amount and the fluid which was lost in such a manner was insignificant and could not account for the "settling" of the neoplasms. Furthermore, the inferior neoplasm showed the same shrinking effect and no injection was made in it. Hence, it could be assumed that the vasoconstriction action of the injected fraction was the most important cause for the partial collapse of these keloids. The loss of the tissue fluid was also noted in the sternal keloids, since corrugations appeared on the surface of these "washboard keloids."

#### DEDUCTIONS FROM THESE EXPERIMENTAL RESULTS

These observations were confirmed with similar experiments, which were performed in a similar manner, in the same individual.

Since it is known that vasoconstriction of the peripheral arterial buds will have the tendency to improve a localized edema of the tissue, it is our assumption that these keloids contain a considerable amount of transudate. When vasoconstriction is produced, as with our experimental material, this tends to lessen stasis in such areas with the actual observation of a shrinking process in the neoplasm which followed the improvement in the tissue edema.

To put these results another way, there is now evidence that keloids are not totally composed of connective tissue. There is an abundant amount of tissue fluid transudate which probably has been produced by a pathological change in the hydrostatic and the osmotic pressures of the involved areas. As the edema displaces the tissue spaces, connective tissue is formed, but the edema persists to a considerable extent.

However, by at least partially reversing this pathological process, by peripheral vasoconstriction with the use of our experimental injected fraction, which produces the same final clinical effects whether introduced subcutaneously or directly into the neoplasm, this stasis is relieved with a shrinkage of the keloids in various portions of the body.

#### SUMMARY

1. The psychological importance of these new growths is emphasized.
2. The rôle which vasoconstriction plays in the governing of tissue fluid tension is reviewed.
3. The microscopic pathology of keloids, hypertrophic scars, and similar entities is discussed, along with the various clinical aspects of each neoplasm.
4. The physiological phenomena are reviewed which produce the tissue fluids.

A description is given of the production of tissue edema.

5. The peculiar anatomy of the skin circulation is described.

6. The authors have reviewed the results of tissue fluid extravasation in various diseases and the nature of the pathophysiology which results.

7. This phenomenon is discussed when it occurs in the tissue spaces of the skin.

8. The relationship of the formation of skin edema is reviewed in view of its probable relationship to the formation of connective tissue and the formation of keloids and related neoplasms.

9. The authors' experiments for the partial reduction of skin edema, in a case of keloidosis, are presented. With decrease in the local transudate, there resulted a shrinking of the keloids which was discernible clinically.

10. Peripheral vasoconstriction seems to produce a reduction in the firmness of keloids by the resultant reduction in the localized skin edema which apparently is present in keloids.

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## CHLOROPHYLL\*

### AN EXPERIMENTAL STUDY OF ITS WATER SOLUBLE DERIVATIVES IN WOUND HEALING

LAWRENCE W. SMITH, M.D. AND ALFRED E. LIVINGSTON, PH.D.  
PHILADELPHIA, PENNSYLVANIA

THE problem of wound healing becomes of paramount importance in time of war. In the intervals between wars somewhat desultory and fragmentary investigations continue to be carried on in this general field, but the bulk of research is directed at other more spectacular issues of current interest. The prosaic, commonplace problem of the repair of wounds, like the proverbial poor relative, is always with us, and is dismissed as one of little interest or likelihood of acclaim. In the past two or three years, however, medical literature has devoted a very considerable percentage of its space to studies relating to the treatment of burns and wounds. It is obviously impossible for any one individual to familiarize himself with more than a small fraction of this literature, much less carry out in his own practice the thousand and one recommendations for the treatment of such injuries.

For that reason, it is well to adopt a conservative and frankly skeptical point of view regarding the relatively extravagant claims of each enthusiastic contributor to the rapidly growing chemotherapeutic armamentarium available for the treatment of burns and other traumatic injuries. Such publications as the recent National Research Council's Military Surgical Manual No. 5<sup>20</sup> reflect this sane approach. Likewise, the contributions of Bowers,<sup>6</sup> Whipple,<sup>25</sup> Waugh,<sup>27</sup> Harkins<sup>16</sup> and Brush and Lam<sup>7</sup> to this field present a most encouraging and hopeful attitude. They all stress the basic physiological principles involved in the healing process which have been all too frequently disre-

garded until comparatively recently, although Carrel<sup>9</sup> and his associates over twenty-five years ago recognized their importance and evolved certain fundamental laws in respect to wound healing.

These earlier investigators developed a mathematical formula of geometric progression in respect to the estimated time required for repair of any wound, based on its surface area. They recognized that larger wounds tended to heal more rapidly than small ones; that the repair phenomenon was influenced by age, tissues from older individuals requiring longer to heal than those of children. They noted the so-called "lag" or latent period between the time the injury occurred and the beginning repair phenomenon, which is still credited to the biophysical changes associated with the inflammatory exudative phase of the process. And it was Carrel who evolved the "tréphone" theory of enzymatic growth stimulating factors being produced through tissue destruction or inflammatory cell metabolism. "Laudable pus" was explained on this same basis, as a necessary irritant to induce cell proliferation, for in its absence, repair was retarded or ceased altogether.

Menkin's<sup>19</sup> now classical studies on inflammation have gone a long way to explain these various phenomena by sound physicochemical theory; stressing the importance of the hydrogen ion concentration of the tissues, the rôle of fibrinolysin, the place of the euglobulin fraction of the exudate (necrosin) which appears to be responsible for the subsequent course of events following the initial injury, and the

\* From the Departments of Pathology and Pharmacology, Temple University School of Medicine, Philadelphia. Aided by a grant from the Committee on Therapeutic Research of the Council on Pharmacy and Chemistry of the American Medical Association.

value of the pseudoglobulin chemotactic fraction (leukotaxin). Tissue culture studies have emphasized the importance of these metabolic or breakdown enzymic products of tissue injury as evidenced by the routine use of such tissue extracts as splenic extract, embryonic tissue juice, "leucocytic cream" and the like as an integral part of the usual media employed.

Currently, a good deal of interest has been shown in a product devised by Sperti<sup>23</sup> and his associates for the treatment of minor burns and injuries, which they have termed "Bio-dyne" ointment. Its use is predicated on the same fundamental theory that cells liberate a growth stimulating factor when injured or destroyed. These workers have employed yeast cells injured or destroyed by ultraviolet irradiation as the source of their growth stimulating factor or "hormone." Cook and Fardon<sup>21</sup> and Nutini<sup>21</sup> from the same laboratories review the concept of wound hormones from the time of Virchow's "formative stimulus" in 1858, and stress the evidence which they have obtained experimentally of the production by injured cells of substances which "promote the proliferation and metabolism of living cells."

In our own studies we have noted the marked "boosting" effect of leucocytic cream extract on cell growth in tissue cultures.<sup>24</sup> We believe the evidence is convincing that some substance or substances derived from injured or dead tissue or inflammatory cells are the chief factors responsible for initiating the reparative phase of any local destructive process regardless of the etiologic agent producing the immediate injury. It appears equally apparent that the so-called lag period before repair ordinarily begins is dependent upon the catabolic cell changes resulting from the injury. Thus, the entire exudative and reparative phases of tissue injury might be thought of in terms of a series of complicated chemical reactions which undoubtedly in due course of time can be reduced to mathematical equations. One gains the impression that the reparative

phase of wound healing is dependent upon the accumulation of an adequate amount of the growth stimulating factors to neutralize and hold in check the catabolic phenomena. Whether this mechanism is primarily dependent upon the liberation of these stimulating factors quantitatively in respect to the number of cells injured or destroyed, or whether these products are actually enzymes or "hormones" capable of propagation interstitially in the tissue fluids is uncertain and perhaps not strictly pertinent to the problem at this time.

In any event, therapeutic efforts to reduce this lag period either by diminishing the catabolic phase or by stimulating the anabolic, proliferative processes are the objective desideratum of all investigators. It is apparent that gross bacterial infection delays healing, so that one aim of any treatment is to produce bacteriostasis. At the same time it is not at all certain that complete bacterial sterilization is either necessary or even advisable, for it is quite possible that minimal saprophytic surface contamination may augment the reparative proliferation by supplementing the necessary stimulating factor with the breakdown of the bacteria themselves. It is equally obvious that a poor blood supply as occurs in chronic indolent ulcers, especially those associated with x-ray burns or on a varicose vein basis is another important factor. In these latter conditions, a slowly developing fibrosis with resultant hyalinization of the collagen plays an important part in the retardation of the repair process through further cutting down the blood supply.

With these theoretical considerations in mind, we have joined the vast group of investigators in this field in an attempt to add our contribution toward the solution of the problem. In view of the considerable discussion which has been raised in the past few years regarding the possible place of chlorophyll in our therapeutic armamentarium, we have undertaken a study on wound healing using water soluble chlorophyll preparations made up in various ways

(as solutions, jellies, and ointments) in the treatment of experimentally induced burns and wounds in rats, guinea pigs, rabbits and dogs, as well as in a limited number of clinical cases.

In order properly to evaluate the value of chlorophyll\* therapeutically, a considerable number of other agents were studied in identical manner, using standard surgically induced wounds or dry heat burns. The agents† employed were the following:

1. Chlorophyll—0.2 per cent alkaline saline solution (pH 7.3-7.8)
2. Chlorophyll—0.2 per cent acid buffered solution (pH 6.6-6.8)
3. Chlorophyll—lanoline base ointment—0.5, 1.0, 2.0 and 3.0 per cent
4. Chlorophyll—petrolatum-cholesterol base ointment—2.0 per cent
5. Chlorophyll—hydrophilic base jelly—1.0 per cent
6. "Bio-dyne" ointment
7. Vitamin B complex ointment—1 per cent
8. Vitamin C ointment—0.1 per cent
9. Vitamin D (cod-liver oil) ointment
10. Methionine ointment—0.05 per cent
11. Castilian malva used as 10 per cent infusion
12. Sulfanilamide (powdered)
13. Sulfathiazole (powdered)
14. Sulfathiazole ointment—5 per cent
15. Sulfadiazine spray—2 per cent
16. Scharlach R ointment
17. Tetrodine dusting powder—6 per cent iodine
18. Controls—untreated

\* Whenever the term "chlorophyll" is used in these studies, the water-soluble derivatives are meant, the term "chlorophyll" being used solely for the sake of brevity.

† ACKNOWLEDGMENTS: Agents No. 1 to 5—The experimental aqueous soluble chlorophyll products have been generously supplied us through the courtesy of the Rystan Company of New York, sole appointee of the Lakeland Foundation of Chicago, in accordance with the regulations of the Federal Food, Drug and Cosmetic Act relative to therapeutic products. Agent No. 6—The Bio-dyne ointment was kindly supplied us by the Sperti Laboratories of Cincinnati. Agent No. 9—The cod liver oil ointment (Gadumont—E. L. Patch Co.) was purchased in the open market. Agent No. 10—The methionine was supplied for experimental study by Merck & Company of Rahway, N.J., and the other Merck products used were made available through our own pharmacy. Agent No. 11—The Castilian Malva was supplied us by the Upjohn Company of Kalamazoo, Michigan. Agent No. 17—The Tetrodine dusting powder was supplied us by the Tyler Laboratories of Brooklyn, N.Y.

## PROCEDURE

In the smaller animals—rats, guinea pigs and rabbits—under nembutal anesthesia, symmetrical, roughly circular, 1.0 cm. areas of skin were excised from the thorax, abdomen or back, after first shaving and painting the operative field with tetrodine. In the rats, guinea pigs and rabbits, a single pair of lesions was produced. As in Clark's recently reported studies,<sup>10</sup> the left side was regularly used as the control, the right side for the experimental treatment. In the dogs it was possible to make as many as four pairs of 2.5 cm. lesions. In these animals the anterior pair of lesions were used as controls, the left, right and posterior pairs as the experimental areas. The procedure varied somewhat in this group inasmuch as it has been impossible to obtain dogs in the numbers desired. Thus as many as three test agents might be employed simultaneously on the same animal. This is open to the criticism that the amount of systemic response from absorption of the various agents is difficult to evaluate and there might therefore be a cumulative effect. However, it is believed that this criticism can be satisfactorily answered, as in no instance was such multiple testing employed without also testing a control animal in which only a single agent was used. The entire method is relatively crude but follows the pattern employed by other investigators in this field such as Whipple,<sup>23</sup> Thompson<sup>26</sup> and Ravdin, Harkins,<sup>16</sup> Brush and Lam,<sup>7</sup> Clark,<sup>10</sup> Boehringer,<sup>5</sup> Buergi<sup>6</sup> and Gruskin.<sup>14</sup> It is dependent upon observing the difference in the rate of healing of standard experimentally induced wounds in a sufficient number of cases to render the results statistically significant.

In the larger animals—dogs—a technic was evolved whereby wounds identical in size could be produced by mounting a Bard Parker knife blade in an adjustable arm attached to a spindle. The spindle has three pinpoints in its foot which hold the instrument in position on the skin surface

with but slight pressure. By revolving the arm, a perfect circle can be cut through the skin and subcutaneous tissues down to the fascial layers. This disc of skin can then be readily excised steriley leaving a clean-based circular defect of whatever diameter is desired—in these particular animals, 2.5 cm. A cork or aluminum ring somewhat larger than the lesion is then cemented to the skin with celloidin, lucite or Johnson & Johnson's liquid adhesive. This enables us to treat the lesions individually with no danger of the test agent contaminating the control area. The test agent is introduced generously on a small piece of double-thickness coarse meshed surgical gauze cut to fit just inside the protecting ring. The intervening areas are loosely packed with crumpled gauze and a binder made of light weight duck applied over the whole trunk. This is held in place by cutting two holes for the forelegs, overlapping the two ends of the binder and sewing them snugly over the back of the animal with interrupted stitches. To protect the field further from harm, a wide collar (6 to 8 inch radius) made of two layers of corrugated cardboard with the corrugations at right angles to each other to prevent its buckling is placed around the dog's neck, and each dog put in an individual cage. Even with these precautions, an occasional dog may get his dressing off, apparently by persistent rubbing against the cage, but in general, the method seems the most satisfactory we have been able to discover.

By this technic, it is comparatively easy to redress the wounds as desired, usually every second or third day. At each examination the extent of healing is recorded by measuring the remaining unepithelialized area, either by using Brush and Lami's technic of actually tracing the edges of the wound on cellophane or by the use of calipers in three transverse directions. It is not believed that planigraphy is necessary, as our chief concern is in respect to the comparative time required to secure complete healing in each case.

This method has the advantage, as Clark has emphasized, of permitting regulated infection to be introduced into the experimental field without much likelihood of contamination of the control area, and thereby making it possible to test the bactericidal or bacteriostatic effect of various agents *in vivo* in a somewhat crude, but at least, comparable manner. The second group of experiments reported here deals with this phase of the problem.

Finally, a similar set of experiments was carried out in which standardized wounds, produced by dry heat, were studied in respect to their healing characteristics. For this purpose, steel cylinders about 2.5 cm. in length and of the diameters desired—2.5 and 5.0 cm., respectively—were hollowed out at one end to permit introducing a flanged tube. This tube serves the double purpose of acting as a handle, and of permitting the introduction of a thermometer into the hollow cylinder. The hollow cavity is filled with mercury to prevent any insulation in respect to the thermometer. The apparatus is then heated to the desired temperature and applied to the skin surface without other pressure than its own, known weight for varying lengths of time, depending on the degree of burn desired. From long experience we have found that there is very little heat loss—roughly 5°C. for each fifteen seconds of application with the smaller, and about 2°C. loss with the larger cylinder over the same time period. For practical purposes, we have found 250°C. applied for thirty seconds gives a very satisfactory mild third degree burn in dogs. As in the case of the surgically produced wounds the lesions are uniform and completely comparable for the purposes of a study such as this. The skin sloughs off in four to five days, leaving a clean-based, circular, ulcerated surface. By protecting the burned areas in the same way as in the preceding surgically induced wounds they can be kept free of bacterial contamination or not, as desired, and topical application of any of the medicaments under study can be carried out satisfactorily.

The experiments included in this report fall into three main groups as already indicated: (1) The healing of experimentally produced clean surgical wounds; (2) the healing of experimentally infected surgical wounds, and (3) the healing of experimentally induced dry heat burns.

TABLE I  
STATISTICAL SUMMARY OF EXPERIMENTAL MATERIAL

	No. of Animals	No. of Lesions	No. Control Lesions	No. Test Lesions
<b>Group I</b>				
Sterile Wounds				
Experiments 1-18 Rats.....	108	216	114	102
19-36 Guinea pigs.....	108	216	114	102
37-54 Rabbits.....	78	156	82	74
55-72 Dogs.....	76	608	164	444
<b>Group II</b>				
Infected Wounds				
Experiments 73-90 Guinea pigs ..	208	416	212	204
91-108 Dogs... . . . .	36	254	84	170
<b>Group III</b>				
Third Degree Burns				
Experiments 109-126 Dogs .....	48	384	108	276
Totals . . . . .	662	2,250	878	1,372

In each of these three main groups there are eighteen separate experiments with each type of animal used, based on the seventeen preparations under study plus a supplementary control group. In the small animals a single test area has been used with a corresponding control area on the opposite side of the animal. In the dogs eight lesions have been produced, two of which have served as controls, and six as test areas. Table I shows in summary form the statistical data relating to the number of experiments, number of animals used, the number of control lesions and the number of experimental lesions tested.

The seventeen preparations tested can be reduced in actual number to eight, by combining the several chlorophyll, vitamin and sulfone compounds as group products. Justification for such simplification of the accumulated data is seen in the similarity

of results within these related group preparations. In the simple, clean, wound healing experiments, identical studies were carried out on rats, guinea pigs, rabbits and dogs. In Group II, consisting of experimentally induced infected wounds only guinea pigs and dogs were used, and in the Group III

TABLE II  
1 PER CENT CHLOROPHYLL IN HYDROPHILIC JELLY BASE  
Time Required for Healing 1.0 Cm. Sterile, Surgically  
Produced Wounds, Expressed in Days

Identification	Control Area	Test Area	Summary
Rat	31	12	8
	32	16	12
	33	16	10
	34	14	14
	35	10	8
	36	14	14
Guinea Pig	31	16	10
	32	18	10
	33	14	14
	34	14	8
	35	12	10
	36	14	10
Rabbit	31	16	12
	32	14	14
	33	16	10
	34	10	8
	35	16	12
	36	12	8
Total . . . . .	254	192	Accelerated . . . . . 14—77.7%
Average . . . . .	14.1	10.6	Unaffected . . . . . 4—22.3%
			Delayed . . . . . 0—0.0

burn experiment dogs were found to be much more satisfactory to work with than any of the smaller animals.

#### EXPERIMENTAL RESULTS

The experimental results are probably best presented for consideration through the following series of tables in which the statistical data have been assembled for comparative study and analysis. Such additional comment or discussion as seems pertinent to an understanding of the figures is included. It does not seem necessary or even advisable to include the individual protocols of all the experiments as the useful information is adequately summarized in the combined tables. However, representative protocols of a couple of typical experiments are presented to illustrate the

method whereby the data as a whole were obtained for statistical analysis. (Tables II and III.)

In the first group of experiments, which deals with the healing of clean, surgically produced wounds, the complete data will be found summarized in Table IV, as these relate to 1.0 cm. wounds in small animals, and to larger 2.5 cm. wounds in dogs, respectively.

Not only is the percentage of such accelerated healing notably better than with any of the other agents studied, but the average time interval required for complete healing decreased by 3.5 days (from 14.1 to 10.6 days) a figure just short of 25 per cent (24.9 per cent). In a considerable number of the animals the differential time interval was as much as six to eight days which is a very real difference. When

TABLE III

I PER CENT CHLOROPHYLL IN LANOLINE OINTMENT BASE

TIME REQUIRED FOR HEALING OF 2.5 CM. STERILE, SURGICALLY PRODUCED WOUNDS IN DOGS  
EXPRESSED, IN DAYS

	Dog No.	Total No. Lesions	No. of Control Lesions	No. of Test Lesions	Time of Healing in Days										Average		
					Control	Test Areas										Control	Test
Experiment No. 57 Test animals.	9 10 11 12 13 14	8 8 8 8 8 8	2 2 2 2 2 2	6 6 6 6 6 6	16 14 16 12 16 14	18 12 14 12 10 8	10 12 12 12 12 10	8 12 10 12 12 12	8 14 12 12 12 14	12 12 14 12 12 10	10 12 14 12 12 14	10 12 14 12 12 14	10 12 14 12 12 14	17 13 15 12 15 14	9.6 13.0 11.6 15.3 11.3 11.3		
Experiment No. 72 Control animals.	69 70 71 72	8 8 8 8	8 8 8 8	.. .. .. ..	12 16 14 12	14 14 16 14	14 18 12 14	12 14 12 16	14 16 12 14	14 16 14 12	12 18 14 12	12 18 14 12	14 14 14 14	13.2 15.7 13.7 13.2			
Total.....	10	80	44	36	..	..	..	..	..	..	..	..	..	..	14.0	12.1	

Summary: Healing accelerated—4 animals or 67.0%  
 " unaffected —1 animal or 16.5%  
 " delayed —1 animal or 16.5%

\* Infected.

In summary, we note that 67 per cent of all the wounds treated by one or another preparation of chlorophyll healed more rapidly than their controls. This percentage varies from 55 per cent in the case of the acid buffered aqueous solution to 75 per cent with the 1 per cent hydrophylic base jelly as a vehicle. Referring to Table II we see that, using the hydrophilic jelly preparation, as high as 83.3 per cent of the wounds in guinea pigs and rabbits showed such acceleration in the healing process.

the reading is only a matter of two days, (the routine time interval between redressing and examining the wounds), as Brush and Lam have emphasized, one is justified in querying any actual effect of the agent under study. But when the time required for healing is reduced by one-fourth in from two-thirds to three-quarters of a series of over four hundred lesions, it would seem to indicate that chlorophyll does cause some biologic response in respect to stimulating cell growth which can be put to a useful

purpose in the many problems associated with wound healing.

This stands out particularly prominently if one summarizes the results obtained with various vitamin and sulfone compounds (Table v), as well as with the various miscellaneous agents tested by ourselves and by Brush and Lam in which it can be seen at a glance that little or no favorable effect upon the rate of healing

itself actually bactericidal, but that it does exert a definite bacteriostatic effect *in vitro*, apparently through its oxidative action. Its mode of action *in vivo* is still obscure, but it is believed that interference with fibrinolysin production and its growth stimulating capacity are also of importance.

In the second group of experiments which deals with artificially infected surgically produced wounds, the data in summary

TABLE IV  
HEALING OF STERILE, SURGICALLY INDUCED WOUNDS

	Rats			Guinea-Pigs			Rabbits			Dogs			Summary						
	No. Animals	Healing Accelerated	Healing Unaffected	No. Animals	Healing Accelerated	Healing Unaffected	No. Animals	Healing Accelerated	Healing Unaffected	No. Animals	Healing Accelerated	Healing Unaffected	Total Number of Animals	Number Accelerated	Accelerated Per Cent.	Number Unaffected	Unaffected Per Cent.	Number Delayed	Delayed Per Cent.
Chlorophyll—alkaline solution	6	4	1 1*	6	3	2 1*	4	2	1 1	4	3	1 0	20	12	60	5	25	3	15
Chlorophyll—acid solution	6	4	2 0	6	4	1 1*	4	1	3 0	4	2	2 0	20	11	55	8	40	1	5
Chlorophyll—lanoline ointment	6	4	2 0	6	4	2 0	6	4	1 1*	6	4	1 1*	24	16	67	6	25	2	8
Chlorophyll—cholesterol ointment	6	5	1 0	6	4	2 0	6	4	2 0	6	5	1 0	24	18	75	6	25	0	0
Chlorophyll—hydrophilic jelly	6	4	2 0	6	5	1 0	6	5	1 0	6	4	2 0	24	18	75	6	25	0	0
<b>Total chlorophyll</b>	<b>30</b>	<b>21</b>	<b>8 1*</b>	<b>30</b>	<b>20</b>	<b>8 2</b>	<b>26</b>	<b>16</b>	<b>8 2</b>	<b>26</b>	<b>18</b>	<b>— 1</b>	<b>112</b>	<b>— 5</b>	<b>6</b>	<b>31</b>	<b>27 5</b>	<b>6</b>	<b>3 5</b>
Bio-dyne	6	2	3 1*	6	2	4 0	4	2	2 0	4	1	3 0	20	7	35	12	60	1	5
Vitamin B ointment	6	1	4 1	6	0	6 0	4	1	3 0	4	0	3 1*	20	2	10	16	80	2	10
Vitamin C ointment	6	2	3 1*	6	1	4 1	4	0	4 0	4	1	3 0	20	4	20	14	70	2	10
Vitamin D ointment	6	2	4 0	6	2	4 0	4	1	2 1*	4	0	3 1	20	5	25	13	65	2	10
Methionine ointment	6	3	2 1	6	2	4 0	4	2	2 0	4	1	3 0	20	8	40	11	55	1	5
Castilian mafva infusion	6	1	4 1*	6	2	3 1*	4	1	3 0	4	2	2 0	20	6	30	12	60	2	10
Sulfanilamide powder	6	0	2 4	6	0	3 3	4	0	2 2	4	0	1 3	20	0	0	8	40	12	60
Sulfathiazole powder	6	0	3 3	6	0	2 4	4	0	3 1	4	0	2 2	20	0	0	10	50	10	50
Sulfathiazole ointment	6	0	2 4	6	1	3 2	4	0	1 3	4	0	2 2	20	1	5	8	40	11	55
Sulfadiazine spray	6	1	4 1	6	0	4 2*	4	1	1 2	4	0	1 3	20	2	10	10	50	8	40
Scharlach R ointment	6	2	3 1*	6	3	3 0	4	1	3 0	4	1	2 1	20	7	35	11	55	1	5
Tetradine powder	6	1	3 2	6	0	4 2	4	0	2 2	4	0	3 1	20	1	5	12	60	7	35
Control	6	—	—	6	—	—	4	—	—	2	—	—	18	—	—	—	—	—	—
<b>Totals</b>	<b>108</b>	<b>108</b>	<b>—</b>	<b>78</b>	<b>—</b>	<b>—</b>	<b>76</b>	<b>—</b>	<b>—</b>	<b>370</b>	<b>—</b>	<b>—</b>	<b>—</b>	<b>—</b>	<b>—</b>	<b>—</b>	<b>—</b>	<b>—</b>	<b>—</b>

\* Infection.

was obtained, and indeed, in a not insignificant percentage of the wounds there was an appreciable retardation noted in the rate of healing. As a matter of collateral interest, it should be mentioned that where actual delay in healing occurred in the animals treated with chlorophyll there was secondary infection present. That aspect of the problem is more clearly seen in the second group of experiments in which infection was introduced into the wounds. It has already been brought out in another paper of this series<sup>24a</sup> that chlorophyll is not of

form are presented in Table vi. Here again, it is to be noted that almost the same relative acceleration in healing is noted in the chlorophyll group as compared with the other test agents as in the uninfected series of cases. However, in the group of miscellaneous agents, several of which are more or less antiseptic in their action, there is a definite shift in the picture toward more rapid healing with a corresponding drop in the delayed healing percentage figures. This is particularly striking in the case of "Tetrodine," a stable aqueous

preparation of iodine, as well as in the various sulfone compound treated lesions. Of the three sulfa drugs tested in this

TABLE V  
RATE OF HEALING OF EXPERIMENTAL SURGICAL WOUNDS

Test Agent	Accelerated, Per Cent	Unaffected, Per Cent	Delayed, Per Cent
Chlorophyll preparations.....	67.0	27.5	5.5
Vitamin ointments.....	18.4	71.6	6.0
Sulfa compounds.....	3.8	45.0	51.2
*Miscellaneous.....	19.4	55.1	25.5

\* See Table IV in this article and Table II in Brush and Lam's (*loc. cit.*).

respect, sulfadiazine in a 2 per cent spray seemed the most effective in controlling infection, and thereby, indirectly hastening repair. Bio-dyne, here as in the clean

wounds appeared to have an appreciable accelerating effect from the percentage standpoint, but actually this difference was hard to evaluate, because it was only by a matter of a couple of days in the majority of cases. Scharlach R ointment in our hands had little or no effect on the rate of growth. This independently confirmed the report by Brush and Lam. The same inconclusive evidence was obtained in respect to the use of methionine and the various vitamin ointments as well as Castilian malva infusion preparations so far as their effect upon wound healing is concerned. (Table VII.)

In the third group of experiments which were designed to show the healing effect of topical applications of various agents on standard dry heat burns of varying size and

TABLE VI

HEALING OF SURGICALLY INDUCED WOUNDS, EXPERIMENTALLY INFECTED WITH 0.5 CC. OF A MIXTURE OF STAPHYLOCOCCUS AUREUS (STRAIN C-209) AND STREPTOCOCCUS HEMOLYTICUS (LANCEFIELD GROUP A STRAIN C-203) TWENTY-FOUR HOUR BROTH CULTURES

Test Agent	Guinea Pigs			Dogs			Summary						
	No. Animals	Healing		No. Animals	Healing		Total Lesions	Healing			Delayed	Per Cent	
		Accelerated	Unaffected		Accelerated	Unaffected		Accelerated	Unaffected	Per Cent			
Chlorophyll—alkaline solution.....	12	8	2	2	2	4	16	11	69	3	19	2	12
Chlorophyll—acid solution.....	12	9	2	1	2	4	16	12	75	3	19	1	6
Chlorophyll—lanoline ointment.....	12	6	4	2	2	6	18	10	55	5	28	3	17
Chlorophyll—cholesterol ointment.....	12	5	6	1	2	6	18	9	50	8	44	1	6
Chlorophyll—hydrophilic jelly.....	12	7	4	1	2	6	18	12	67	5	26	1	7
Total chlorophyll.....	60	35	18	7	10	26	86	54	63	24	28	8	9
Bio-dyne ointment.....	12	4	6	2	2	12	24	9	38	12	50	3	12
Vitamin B ointment.....	12	2	10	0	2	12	24	5	21	16	67	3	12
Vitamin C ointment.....	12	1	10	1	2	12	24	3	13	19	79	2	8
Vitamin D ointment.....	12	3	7	2	2	12	24	6	25	16	67	2	8
Methionine ointment.....	12	3	6	3	2	12	24	7	29	12	50	5	21
Castilian malva infusion.....	12	2	8	2	2	12	24	6	25	15	63	3	12
Sulfanilamide powder.....	12	4	6	2	2	12	24	7	29	14	58	3	13
Sulfathiazole powder.....	12	3	6	3	2	12	24	5	21	13	54	6	25
Sulfathiazole ointment.....	12	3	7	2	2	12	24	7	29	13	54	4	17
Sulfadiazine spray.....	12	4	7	1	2	12	24	7	29	15	63	2	8
Scharlach R ointment.....	12	2	9	1	2	12	24	5	21	17	71	2	8
Tetrodine powder.....	12	6	4	2	2	12	24	11	45	10	43	3	12
Control.....	4	..	..	..	2	..	20	..	..	..	..	..	..

intensity, a striking parallelism was observed in comparison with the previous clean and infected wound experiments. These data are summarized in Table VIII.

TABLE VII

COMPARATIVE RATE OF HEALING OF CLEAN AND INFECTED WOUNDS USING CHLOROPHYLL, VITAMIN OINTMENTS, SULFA COMPOUNDS AND TETRODINE.

Test Agent	Accelerated		Unaffected		Delayed	
	Clean	Infected	Clean	Infected	Clean	Infected
Chlorophyll preparations	67.0	63.0	27.3	28.0	35.1	9.0
Vitamin ointments	18.4	19.4	71.6	70.8	6.0	9.7
Sulfa compounds	3.8	27.1	45.0	57.3	31.2	15.6
Tetrodine powder	3.0	45.0	60.0	43.0	35.0	12.0

As in the previous studies, the response in the rate of healing was found to be greater with the various chlorophyll preparations than with any of the other test agents,

ranging from 62 to 83 per cent, with an average figure of 71 per cent. There seemed to be no striking relative differences in this rate between the larger (5.0 cm.), more severe burns and the smaller (2.5 cm.) lesions produced at a lower temperature, although obviously the larger lesions took somewhat longer to heal. In this series of animals the Bio-dyne did not seem to be particularly effective in hastening the repair process, although the resultant scar tissue formation was of excellent quality with but little contraction and deformity. The methionine and Scharlach R (aminoazotoluene azobetanaphthol) ointments and the Castilian malva wet dressings showed up a little better in this group of experiments with a slight acceleration of the healing process in from 40 to 50 per cent of the cases. It is our impression that these agents have more effect upon epithelializa-

TABLE VIII

HEALING OF EXPERIMENTALLY INDUCED, DRY HEAT, MILD, THIRD DEGREE BURNS IN DOGS

Test Agent	2.5 Cm.						5.0 Cm.						Summary												
	250°C.— 20 Seconds			300°C.— 30 Seconds			250°C.— 20 Seconds			300°C.— 30 Seconds			Healing			Healing									
	No. Animals	No. Lesions	Healing	Total No. of Lesions Treated	Accelerated Per Cent	Unaffected Per Cent	Delayed Per Cent	Total No. of Lesions Treated	Accelerated Per Cent	Unaffected Per Cent	Delayed Per Cent														
Chlorophyll—alkaline solution	4	8	6	2	0	4	2	2	2	0	8	5	2	1	4	2	2	0	24	15	62	8	33	1	3
Chlorophyll—lanoline ointment	4	4	2	1	1	8	5	3	0	0	4	3	1	0	8	6	1	1	24	16	67	6	33	2	8
Chlorophyll—jelly	4	4	3	1	0	4	4	0	0	0	8	6	2	0	8	1	1	0	24	20	83	4	17	0	0
Chlorophyll—wet dressing + ointment	4	8	6	2	0	8	6	1	1	1	4	2	1	1	4	2	2	0	24	16	67	6	25	2	8
Chlorophyll—wet dressing + jelly	4	6	5	1	0	6	4	2	0	0	6	4	2	0	6	5	1	0	24	18	75	6	25	0	0
Total chlorophyll	20	30	22	7	1	30	21	8	1	30	20	8	2	30	22	7	1	120	85	71	30	25	5	4	
Bio-dyne ointment	4	6	1	4	1	6	2	4	0	6	1	5	0	6	1	3	2	24	5	21	16	67	3	12	
Vitamin B ointment	2	3	1	2	0	3	0	2	1	3	0	3	1	2	0	12	2	17	9	3	1	8			
Vitamin C ointment	2	3	2	1	0	3	1	1	1	3	0	2	1	3	1	2	0	12	4	33	6	50	2	17	
Vitamin D ointment	2	3	1	1	1	3	2	1	0	3	1	2	0	3	0	2	1	12	4	33	6	50	2	17	
Methionine ointment	2	3	2	1	0	3	1	2	0	3	1	1	1	3	2	1	0	12	6	50	5	42	1	8	
Castilian malva infusion	2	3	1	2	0	3	1	1	1	3	2	1	0	3	1	2	0	12	5	42	6	50	1	8	
Sulfanilamide powder	2	3	0	1	2	3	0	2	1	3	0	0	3	3	0	1	2	12	0	0	4	33	8	67	
Sulfathiazole powder	2	3	0	2	1	3	0	2	1	3	0	1	2	3	0	2	1	12	0	0	7	58	5	42	
Sulfathiazole ointment	2	3	0	2	1	3	0	1	2	3	1	2	0	3	0	1	2	12	1	8	6	50	5	42	
Sulfadiazine spray	2	3	1	1	1	3	0	2	1	3	0	2	1	3	0	1	2	12	1	8	6	50	5	42	
Scharlach R ointment	2	3	1	2	0	3	2	1	0	3	2	0	1	3	1	2	0	12	6	50	5	42	1	8	
Tetrodine powder	2	3	1	2	0	3	1	1	1	3	0	2	1	3	1	2	0	12	3	25	7	58	2	17	
Control	2	4	—	—	—	4	—	—	—	4	—	—	—	4	—	—	—	16	—	—	—	—	—	—	

tion than upon the development of healthy granulation tissue as is the case with chlorophyll. Likewise, it should be noted that the actual amount of acceleration with these three agents seldom exceeded two to three days as compared with the 25 to 30 per cent obtained with chlorophyll. In the case of the vitamin preparations, a similar slight acceleration in the healing rate in some of the animals was observed, but this was counterbalanced by a like delay in others so that the net result was of no statistical significance. With the sulfa

that obtained with any of the other preparations studied and five times as great as that recorded with the various sulfa compounds. In only 6 per cent of the animals on which chlorophyll was used was any delay in healing noted and in the majority of those cases there was secondary infection present not controlled by the drug.

#### COMMENTS

An attempt has been made in the foregoing experiments to evaluate the effect of topical application of various agents currently of interest in the treatment of wounds, of both traumatic and thermal origin. A standard procedure has been followed that the results might be critically compared. The method has the advantages of simplicity and uniformity which might make it useful to others working in this same field. By establishing such a standard technic, experimental studies from different laboratories could be more satisfactorily compared or contrasted, data could be easily duplicated for purposes of confirmation, and a universal understanding of each other's reports might hasten the solution of many acute problems in this field.

In these studies the objective has been strictly empirical and factual: to note the length of time required to heal a standard wound. No attempt has been made to theorize or to explain the manner of action of any of the agents under consideration. In earlier papers in this series, it has been shown that chlorophyll has a growth stimulating effect upon fibroblasts in tissue culture, and that it possesses certain bacteriostatic capacities. Its mode of action is still most obscure, but the practical application of these properties, which it has been shown to possess, to wound healing has been substantiated by the data presented in this report. We believe the use of chlorophyll should be extended widely in the clinical field possibly in conjunction with or subsequent to the more actively anti-bacterial agents such as the sulfa drugs. Its use in war injuries and burns

TABLE IX  
SUMMARY—ALL EXPERIMENTS

Test Agent	Total Lesions Tested	Accelerated		Unaffected		Delayed	
		No.	Per Cent	No.	Per Cent	No.	Per Cent
Chlorophyll preparations.....	448	304	67.9	120	26.7	24	5.4
Vitamin ointments.....	228	40	17.5	162	71.0	26	11.5
Sulfa compounds.....	304	31	10.1	144	47.4	120	42.5
Bio-dyne ointment.....	88	26	29.5	55	62.5	7	8.0
Methionine ointment.....	76	26	34.2	43	56.5	—	9.3
Castilian Malva infusion.....	76	27	35.5	43	56.5	6	8.0
Scharlach R ointment.....	76	23	30.2	43	56.5	10	13.3
Tetradine powder.....	76	15	19.7	44	57.9	17	22.4
Totals.....	1,372	492	35.8	654	47.6	226	16.6

compounds a very definite delay in healing was found to be the rule, which was even more striking than that noted in the clean surgical wound series. Only in the presence of infection did the sulfa drugs exhibit their real effectiveness, permitting healing to proceed more promptly than in the control lesions through their bacteriostatic action.

In Table IX will be found summarized the results of all three groups of experiments. It will be noted, that, including all three types of experimentally induced lesions in all four test animals, the rate of healing was accelerated appreciably in 67.9 per cent of the animals on which the various chlorophyll preparations were used. This percentage is approximately twice

seems particularly indicated at this time in view of the results recorded here.

It has been of great interest to us to learn of the comparative ineffectiveness of any of the vitamins applied locally. While much of the recent work, such as that of Bartlett, Jones and Ryan<sup>2</sup> and Hunt,<sup>15</sup> has emphasized the value of an adequate vitamin C dietary intake in wound healing, its local application as demonstrated in these studies is practically negligible. Slightly more favorable results have been noted by Abramowitz<sup>1</sup> and Hardin<sup>16</sup> with the use of vitamin A and D ointments locally, but we have been unable to confirm this in these experiments. In the use of the sulfa drugs the resultant delay in wound healing is more than offset by their value in controlling infection. Our studies merely tend to confirm other, similar observations in this respect, notably those of Goldberger<sup>17</sup> and Bick.<sup>4</sup> In the clinical field the recent work of Reid,<sup>22-23</sup> Thompson and Raydin,<sup>2</sup> Koster and Kasman,<sup>18</sup> Allen and Koch,<sup>2</sup> Whipple<sup>24</sup> and Elman<sup>12</sup> lay emphasis on the importance of correcting any existent hypoproteinemia which may exist. This aids in reducing the "lag" period by stimulating normal, healthy cell growth and providing the necessary adequate protein nutritional requirements.

Methionine was employed in this study with the idea of supplying the well established growth stimulating sulphydryl radical. The results would seem to point to at least a partial utilization of this factor, although nothing very conclusive can be drawn as an inference with such a relatively small number of lesions. Castilian malva has been used in certain parts of the southwest and Mexico, more or less empirically, in various circulatory disturbances of the extremities accompanied by tissue breakdown with what have been claimed to be most encouraging results. It is now under laboratory and clinical investigation to learn something of its effects and pharmacologic action. In our studies, infusions, prepared from the crude, dried leaf have been used both in tissue culture and wound

healing experiments. That the drug has some definite pharmacologic activity appears unquestionable, and further investigation into its behavior seems indicated.

In these wound healing experiments Bio-dyne ointment has likewise shown some slight suggestion of accelerating the reparative process. Its antiseptic component has been fairly effective in controlling infection, but again, any beneficial results noted have not been particularly striking. With Tetrodine, it is our impression we are dealing with an agent with all the antiseptic effects of tincture of iodine, but with very few if any of the objectionable features of tincture. It does not appear to delay healing appreciably because of its relatively minimal toxic effect upon tissues, and indeed, healing is definitely hastened in infected wounds as compared with the control animals by overcoming the infection. In this respect, it seems more effective than any of the sulfa compounds studied. Scharlach R ointment appears to be very ineffectual in accelerating the wound healing mechanism. Its much vaunted epithelial stimulating action seems practically negligible in our experience, and this impression has been recorded likewise recently by Boehringer and by Brush and Lam.

#### SUMMARY AND CONCLUSIONS

1. The effect upon the healing of 1,372 experimentally induced wounds and burns by the topical application of seventeen medicinal preparations is presented.
2. A control series of 8-8 similar lesions is included.
3. The agents tested include: Chlorophyll (aqueous soluble derivatives) in five vehicles, vitamin A, vitamin B complex, vitamin C ointments, bio-dyne ointment, methionine ointment, Castilian malva infusion, sulfanilamide powder, sulfathiazole powder and ointment, sulfadiazine spray, Scharlach R ointment, and tetrodine dusting powder.
4. Of all these agents, only the chlorophyll preparations consistently showed any statistically significant effect in ac-

celerating the healing of both traumatic and thermal wounds.

5. Wound healing in 448 lesions in this group was accelerated by 24.9 per cent in time, in 304 or 67.9 per cent of the cases.

6. Vitamin B, C and D ointments showed no appreciable effect.

7. Bio-dyne and methionine ointments and Castilian malva wet dressings (infusion) caused a slight acceleration of healing in somewhat less than a third of the cases, but of less than 10 per cent in time.

8. The sulfa compounds caused definite retardation of the healing process except in the presence of active infection.

9. Scharlach R ointment was essentially inert, acting merely as a protective dressing similar to boric ointment or petrolatum gauze.

10. Tetrodine, an active, stable, aqueous soluble iodine preparation (with an iodine content of 4 per cent combined iodine and 2 per cent free iodine) reduces the healing time in about half the cases when infection is present. In the absence of infection some slight delay in healing is found presumably because of minor tissue irritation.

11. On the basis of these observations it is suggested that chlorophyll preparations should be used much more extensively in the treatment of wounds and burns.

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# IMPLANTATION OF THE URETERS INTO THE LARGE INTESTINE\*

## REPORT OF TWO CASES

RUSSELL STORY FOWLER, M.D.  
Director of Surgery, Wyckoff Heights, Hospital  
BROOKLYN, NEW YORK

THE cloacal condition, which exists normally in fowls and is also the condition which exists during the first weeks of the human embryo, early suggested the thought of making such a deflection of urine through the rectum. Such a method secured a retentive space under control, and was comparatively easy of accomplishment.

In 1790, Petit called attention to the valve-like openings of the ureters, and it is over ninety years since ureterorectal and vesicorectal anastomoses were made by Simon, followed later by Lloyd, and Johnson. The variety of the valve type of operation was also reported by Fowler (1898), Martin, Carl Beck (1899), and later by Frank. Coffey made an extensive investigation concerning the valve function of the duct openings of both the common duct of the liver and of the pancreas. He proved experimentally and mechanically that the valve effect is caused by the extension of the duct for some distance between the mucosa and the muscularis.

Cabot has shown that the ureter is similarly placed in the wall of the bladder for a distance of 1 to 1.5 cm. Direct transplantation of the ureters failed in not providing for compression of the ducts by internal pressure, thus permitting dilatation of the ureters and regurgitation into them. The method of transplanting the base (Maydl) or a greater portion of the bladder (Moynihan, 1906) into the wall of the rectum is practical, as it then becomes subject to the same internal tension as the rest of the intestine. This

method is not difficult of accomplishment in the male.

Those operations in which the ureters are transplanted and have been preserved to their tips are correct only in principle if they are made after one of the methods which secures compression of the lumen.

The Coffey operation which Charles Mayo described as practically a divided Martin, is accomplished by separating the ureters that have been isolated and brought through the posterior peritoneum, the distal ends being ligated and buried. A double-needled ligature is attached to the split ends of each ureter. At a point as low as convenient the sigmoid is held in a curved, rubber-covered clamp to protect against the discharge of intestinal contents. The bowel is then incised longitudinally for one and one-quarter inches through the peritoneum and muscularis, but not the mucosa; the mucosa is perforated at the lower end of the incision. The two needles are passed into the lumen of the bowel through the opening and out of its wall, slightly separated, one-half inch lower down, and are used to draw the ureter through the opening into the lumen, where it is held by tying the two threads. The cut muscularis and peritoneum are now closed over the ureter in the incision by two rows of sutures. The second ureter may now be attached or preferably the operation delayed for a later period. The Stiles operation (1907) and that of Mirotworzeff, which method is nearly the same and was reported in 1910, Charles Mayo states secure much

\* Read before the Brooklyn Surgical Society, November 13, 1941.

the same effect by infolding the bowel over the ureter by numerous sutures, like a Witzel gastrostomy.\*

On November 4, 1897, before the Brooklyn Surgical Society Dr. G. R. Fowler presented a case of extrophy of the bladder in which implantation of the ureters into the rectum, by a new and original method, had been performed at the Brooklyn Hospital, September 20, 1896. The history of the case is as follows:

E. W., aged six, referred by Dr. McCleary, was admitted to the Brooklyn Hospital, with extrophy of the bladder and epispadias. In view of the unsatisfactory results following the plastic procedures designed to restore the defect in the anterior abdominal and bladder walls in this class of cases heretofore in use, it was decided to utilize the rectum, as a receptacle for the urine, which, according to O'Bierne, is practically empty during the intervals of defecation, the feces being stored at the sigmoid flexure.

The abdomen was opened in the median line, with the patient in the Trendelenburg position, the rectum being thoroughly cleansed primarily. The ureters were identified in their relation to the vessels, the posterior layer of the peritoneum incised for a sufficient extent to expose them freely, and the ureters traced to their termination upon the bladder wall, from which they were detached. The ends of the ureters were cut off obliquely.

A longitudinal incision 7 cm. long was made in the anterior wall of the rectum, only the serous and muscular coats being included in the incision. The edges of this incision were retracted, a diamond-shaped space in the submucous space being thus exposed. A tongue-shaped flap of mucous membrane, with its base directed upward, was cut from the mucous membrane of the bowel in the lower half of the diamond. This tongue-shaped flap was doubled upon itself in an upward direction in such a manner that one-half of its mucous surface presented anteriorly, where it was secured by one or two catgut sutures. A flap was thus secured, both sides of which were covered with mucous membrane.

The ureters were now placed in the incision with their obliquely cut ends lying upon

\* Here and there some of the above is quoted though not verbatim from Charles Mayo.

the presenting mucous membrane surface of the flap. Two catgut sutures served to secure the ureters in position at this point, and two more were placed in the space represented in the upper half of the diamond, care being taken that these sutures did not invade the lumen of the ureters. The flap-valve and attached ends of the ureters were then pushed into the cavity of the rectum, and the rectal wound closed as follows: The gap in the mucous membrane left by the reflected half of the tongue-shaped flap was first sutured by a running catgut suture. The original wound in the rectal wall was then closed by fine silk sutures, the upper two or three of these being likewise utilized for still further securing the ureters where they passed in the submucous space in the upper half of the diamond. The abdominal wound was then closed.

Prompt recovery followed the operation. The rectum became remarkably tolerant of the presence of urine from the first day following the operation, urination occurring per rectum on an average of every three hours. As time passed this toleration became more pronounced, until at the present time the intervals do not exceed the normal.

The bowel performs without apparent difficulty the double function of a receptacle for both feces and urine. While urination takes place at normal intervals, defecation likewise takes place at normal intervals. The former occurs about once in six hours; the latter takes place but once daily. The movement is generally formed and is not mixed with or accompanied by urine, as far as gross appearances can determine.

Ordinary cleansing after each act of urination suffices to prevent excoriations and eczematous conditions in the anal region, no trace of which is present. The child up to this time, fourteen months after the operation, has shown no evidence of renal disturbance. He attends the public school, and suffers not the slightest inconvenience from the presence of the urine in the rectum.

The following objects are claimed to be obtained by this method of operating:

1. Regurgitation of urine, or passage of feces into the ureters, is prevented by an efficient and permanent valve with a mucous surface applied to the open mouths of the ureters.

2. The circular muscular fibers of the bowel wall make compression upon the ureters as they lie in the space beneath the muscular coat of the rectum, thus securing occlusion, and affording additional security against regurgitation during the act of defecation.

The after-course is as follows: This boy grew up to manhood, married, supported himself, and was free from disease or from trouble of any kind for many years. I saw him sometime in 1927 or thereabouts with his physician, Dr. A. Ross Mathewson. He wished to know if his defect in the abdominal wall could be operated upon and corrected. I advised against such an operation.

The next I heard of W, he was a patient in the clinic of the New York Hospital in 1939 and subsequently was admitted to the New York Hospital and was operated upon May 31, 1941.

The following is a copy of a photostat of the summary of the history taken in the New York Hospital.

History No. 225529. This is the first admission of a fifty year old married white male. The chief complaint was various pains and malaise of one week's duration. His family history was negative including deformities. He had had bilateral inguinal hernioplasties fifteen years ago. His general health was good until two years ago when a chronic cough developed. It had become more severe. He was seen in the pulmonary out-patient department where sputum was negative for A.F.B. and the chest plate showed increased markings in the lungs. He lost twenty-five to thirty pounds in the past two years. Occasionally, the cough was so severe that he might vomit. He had frequent colds, his nose was usually much congested with mucous. He was quite short of breath on exercise but could sleep flat.

The patient was born with complete epispadias, a wide open bladder neck, but apparently without complete evagination of the bladder. At the age of six a bilateral uretero-intestinal transplant was done by Dr. G. R. Fowler, of Brooklyn. The operation was described in two articles, one in the American Journal Medical Sciences, March 1898, and on page 313-314 of volume II, "Treatise on Surgery" by Dr. Fowler (Saunders Co.) 1906. The result, at least until two years ago, has been perfect.

He had no pyelitis-like attacks, no proctitis and no impotence. He has worked regularly. He is married and has two living children. Sexual relations have always been satisfactory in spite of the deformity. The patient had voided rectally every three to four hours night and day. Occasionally, if sleeping very soundly, he might wet the bed; otherwise he had been able to tell when the rectum was full. His wife stated that he had had frequent dull pains in the region of the kidneys, none of which, however, had interfered with his work until two years ago. Two years ago he was sent to the Urological Clinic and Pulmonary Clinic regarding chronic cough. I-v pyelograms showed a coral stone on the right side, with no evidence of function in two hours. On the left side was a poorly functioning hydronephrotic left kidney. Blood urea nitrogen February 10, 1939, was 40. For the past two years, his general health had been poor. He had lost thirty pounds. He had frequent colds, furuncles, and his cough caused considerable trouble. He had also had dull pain in both kidney regions, particularly on the right. Frequency had increased from three to four hours to one and one-half hours. One week before he developed malaise, vague muscle and joint aches, anorexia, and particularly a bowel frequency, that is, passage of feces with each urination, and desire to pass feces. Ordinarily feces are only passed one to two daily. He had been in bed for the past week and eaten very little. He had no chills or fever.

Physical examination revealed a well developed, somewhat underweight, pale, listless male of fifty-one in no distress, but looking ill, and with a uremic odor to the breath. Examination of the head, eyes, ears, nose, throat and neck showed bilateral nasal obstruction (partial) with considerable mucous. The pharynx was chronically inflamed. The chest was clear and the heart negative. Blood pressure was 85/60. There were bilateral strong inguinal hernia repairs. The symphysis pubis appeared wide. There was a suprapubic vertical scar. The penis was wide without complete urethra. This was completely epispadic with a dorsal groove which opened into the bladder. The bladder neck would admit the index finger. The bladder mucosa was pale pink, and smooth. Tests were unremarkable. Rectally, there were small external tabs. The prostate was enlarged about one-half times, slightly nodular on the right side. It could be palpated bimanually

with one finger in the bladder and one in the rectum. Extremities and reflexes were negative.

Filtered specimen of the urine showed a 4+ albumin, concentration to 1015. No sugar was present. Red and white blood cells were seen. Hemoglobin was 12.5 Gm., red blood cells, 4.1 million; white blood cells, 18,700; and an increase of polymorphonuclears. Serology report was negative in 1939. Blood urea nitrogen on admission was 150; thereafter it varied between 132 and 172.

Fluids were forced, particularly parenterally. His output was over 1,000 cc. daily. His general condition, however, failed to improve. X-rays taken showed a coral stone on the right side, and no positive evidence of function on the left side. Accordingly, under local anesthesia a left nephrostomy was carried out. The patient's general condition continued steadily down hill, and following operation his temperature rose to 39.4°C. He became comatose on the first postoperative day. His blood urea nitrogen remained elevated. The patient expired without any striking change, signs or symptoms. Permission for autopsy was obtained.

The body was that of a well developed, moderately obese, white man who appeared slightly older than the stated age of fifty years. The body weighed 69 kilograms and measured 173 cm. in length. There was rigor throughout the body and slight livor over the posterior aspects of the body. The skin of the face and neck showed spots of livid discoloration. The face and neck appeared swollen but no pitting could be elicited. The hair of the head was abundant and gray. The eyebrows were brown. The eyelids were slightly swollen, the right more than the left; this was probably due to edema. There was a small pedunculated papilloma in the outer upper corner of the left eyelid. The eyeballs were moderately protruding. The cornea showed beginning drying. The right pupil was slightly larger than the left, measuring 3.5 mm., the left 3 mm. The right pupil appeared slightly gray, the left black. The conjunctivae were pale. There was a small amount of purulent discharge in the right conjunctiva. There was also purulent discharge in the nostrils. The oral cavity could not be examined because of rigor. Several teeth were absent, others were carious. About the right lower lateral teeth the margin of the gum was red and covered with necrotic material. The lymph nodes of the neck were not palpable.

The skin of the neck was covered with white, dry powdery material (uremic snow?). There was a well healed left rectus incision measuring 6 cm. in length and another well healed surgical incision extended from beneath the umbilicus to the symphysis pubis measuring 7 cm. in length. There was a healed surgical incision above the right iliac crest measuring 12 cm. in length. There was a fistulous opening at the symphysis pubis which entered the region of the bladder. The upper margin of this fistulous opening was marked by a stellate scar. There was a left transverse incision above the kidney extending from the midscapular line to the midclavicular line. This incision was very recent; it had been sutured by black silk and drained by two rubber tubings. There were several needle puncture wounds in the antecubital fossa. The extremities appeared slightly swollen but showed no pitting on pressure.

The usual incisions were made for examination of the chest and abdomen. The contents of the cranium were exposed by an intermastoidal incision.

The peritoneal cavity contained no measurable amount of fluid. The serosal surfaces were smooth and shiny and the relationship of the organs was normal. There were few fibrous adhesions between the appendix and the peritoneum. The appendix was curled up and lay behind the cecum. The pleural cavities contained about 15 cc. of clear serous fluid and the serosal surfaces were smooth and shiny.

The heart weighed 300 Gm. This organ was of normal size and shape. The valvular orifices measured as follows: tricuspid valve 13.5 cm.; mitral valve, 11 cm.; aortic valve 7.5 cm.; pulmonic valve, 8 cm. The myocardium of the left ventricle measured 16 mm. in thickness, that of the right ventricle 4 mm. The chambers were of normal dimensions. The valve leaflets were all smooth and delicate, save for the presence of an atheromatous plaque measuring approximately 1 cm. in greatest diameter in the aortic leaflet of the mitral valve. The foramen ovale was closed. The branches of the coronary artery showed slight sclerosis. The lumen of the vessel was not narrowed at any place. The thoracic aorta showed slight sclerosis; the abdominal aorta was moderately sclerosed. Calcified patches were very few and the degree of calcification scant. Ulceration was absent. The orifice of the right renal artery was very small, measuring only 3 mm. across

(about one-half that of the left). There was slight sclerosis of the base of the aortic leaflet.

The two lungs together weighed 1,800 Gm. This increase in weight of the lungs was due entirely to intense congestion and edema. The bronchi were red and the bronchial tree was filled with a moderate amount of red-tinged mucous exudate. There was a fibrous scar in the posterior part of the apex of the right upper lobe, measuring 3 by 2.5 cm. on the pleural surface. This scar did not effect the underlying lung tissue. No apical scar was noted in the left pleura and calcified nodes were not identified in the lung or in the tracheobronchial lymph nodes. There was moderate anthracosis of the tracheobronchial lymph nodes which were slightly to moderately enlarged. The largest of these measured approximately 2.5 by 2 by 1.5 cm. Several of these anthracotic nodes were soft and one such node was sectioned. A gray-white, firm tumor node measuring 4 by 4 by 2 mm. was found in the mucosa of the left main bronchus close to its bifurcation.

The liver weighed 1,800 Gm. The organ was brown-red, of the usual consistency. It was of normal shape and of approximately normal size. The gallbladder and biliary tract showed no change. The esophagus was normal. There were a few small erosions at the junction of the esophagus with the stomach. The stomach itself presented no change. The mucosa was covered with a moderate amount of tenacious mucus. The small intestine showed no change. The large intestine was also normal. There was great distention of the cecum and rectum. The content of the large intestine was green and soft, in part fluid.

The appendix measured 10 cm. in length. Fibrous peri-appendiceal adhesions have already been mentioned. There were numerous petechiae in the sigmoid colon. The spleen weighed 250 Gm. As the weight indicates the organ was slightly enlarged. The capsule was normal, the follicles distinct and of normal size. The trabecular network could not be defined. The pulp was very soft and a large amount of red pulp material could be readily scraped from the cut surface of the organ. The pancreas measured 23 by 4.5 by 2.5 cm. The organ showed no gross change. The adrenals were of normal size, shape and consistency. The cortex was yellow, the medulla gray.

The right kidney measured 6 by 4 cm. in the two greatest diameters. This organ, as the size

indicates, was very small. It was embedded in a large amount of fatty tissue. The capsule could not be identified, neither could cortex and medulla be defined. The organ consisted of gray-white tissue with numerous minute cavities containing yellowish, turbid material. The right ureter entered the sigmoid-rectal junction 20 cm. above the anal orifice. The right ureter measured approximately 15 mm. in diameter, or approximately 2.5 cm. in circumference. The wall of this ureter was greatly thickened, the greatest thickness measuring approximately 3 mm. This ureter was filled with purulent material. Its orifice at first could not be probed. Further tests, however, showed it to be permeable to water and subsequently a fine probe could be passed through it. The renal pelvis on this side was contracted and filled with a stone which followed the ramification of the calices. Around this stone a large amount of turbid fluid was found.

The left kidney measured 11 by 7 by 4 cm. The left ureter was wider than the right measuring in circumference 4.5 cm. However, the wall of this ureter was not as thick as the right and measured only 2 mm. This ureter in contrast to the right was very tortuous so that it could not be readily probed. The tortuosity was greatest at the pelvic-ureteral junction. The kinking here was so great that it is possible that this contributed to the development of the hydronephrosis. There was also some kinking in the region of the junction of this ureter with the sigmoid colon. This kidney contained no stones. However, there was an incision wound on the lateral aspect of the organ with a catheter lying in and draining the lower calyx of the renal pelvis. This pelvis was dilated. No frank purulent material was identified in this renal pelvis and the content of this ureter was turbid yellowish material similar to that in the right kidney. The ureters were not opened until after fixation of the organ. There was a hemorrhage in the left renal capsule. This kidney, in contrast to the right, was sharply outlined and was free from perirenal adhesions and perirenal inflammation. Two rubber tubes, in addition to the one already mentioned, drained the peripelvic region. The two ureters entered the rectum close to each other. A depression in the mucosa of the rectum measuring 6 mm. across beneath their entry marked this site.

Three vertebrae were cut across. The bone marrow was of normal red color. The bony

meshwork was as usual, or perhaps slightly wider than usual and the bones were of normal consistency, if not slightly softer than normal.

There was a complete epispadias. The bladder was small, measuring approximately 3 by 3.5 cm. in the two greatest diameters. The prostate and seminal vesicles showed no change. Testes and epididymides were free from abnormalities.\*

The following case of unilateral implantation presents some interesting observations:

E. V., a male, age thirty-one, was first seen by the author on April 6, 1940. A diagnosis of intractable fistula of the left ureter with stone embedded in lower end of ureter and with deep abscess was made on the examination and history. He was referred to the Wyckoff Heights Hospital for further observation and operation. It was explained to him that an attempt would be made to restore his ureter and that if this was found impossible the ureter would be implanted into the bowel and an attempt also made to remove the stone. It was explained to him that this method of treatment was advised rather than nephrectomy even though the kidney might prove to be infected and a nephrectomy later be necessary.

For the past four years, the patient had several attacks of pain beginning in the back and radiating to the front of the abdomen. The pain was severe and accompanied by vomiting. During the week of September 25, 1939, he was cystoscoped at Coney Island Hospital and a diagnosis of stone made for which he was operated upon during the week of January 1, 1940. He was subsequently told that it was impossible to remove the stone and that it was pushed down into the bladder during which process the ureter was damaged. A few days later an infection occurred following which the wound healed slowly and a fistula persisted from which urine has been draining ever since. In the latter part of April, 1940, he began running a temperature of  $101^{\circ}$  to  $105^{\circ}\text{F}$ . —normal during the day and elevated at night.

A few days later pus began draining from the sinus as well as urine.

Physical examination revealed a well developed, white male, not appearing acutely ill. Physical examination was negative except for the urinary fistula.

He was cystoscoped on April 7, 1940, by Doctor Mule. There was cloudy bladder urine and a moderately congested trigone. A No. 5 catheter passed easily to the right pelvis and cloudy urine obtained. A filiform could be passed only 1 cm. up the left ureter. No urine could be obtained from the left ureter. A flat plate and intravenous plates were taken. A retrograde pyelogram of the left ureter was attempted but no dye could be forced up the ureter. Diagnosis: Left ureteral calculus; left hydro-ureter and hydronephrosis.

On April 9, 1940, pus was still draining and his temperature was still elevated so the fistulous tract which extended to the depth of about three inches was dilated with an artery clamp and a No. 14 French catheter inserted through the tract.

Four days later the temperature became normal. Dakin's fluid was dropped into the catheter several times daily and as the catheter became displaced it was re-inserted.

On April 28, 1940, nineteen days after the dilatation of the fistula, the temperature remained practically normal. A left rectus incision was made and the abdomen opened. The peritoneum overlying the ureter was incised and a probe was inserted into the fistula. The fistulous tract was dissected down to the ureter. The lower end of the ureter near the bladder was found to be connected by dense scar tissue. The lower end of the fistulous tract near the ureter was found much enlarged. The proximal end of the ureter was separated from the scar tissue. The scar tissue was incised near the bladder and a small stone removed. The incision for the removal of the stone was closed and covered with peritoneum after removal of some of the scar tissue. The ureter was separated from the scar tissue. It was found impossible to embed it in the bladder. The lower sigmoid was mobilized and the ureter implanted in the lower sigmoid just above the rectosigmoid juncture. This was effected by the Fowler technic, i.e., oblique section of the opened end of the ureter; application of this by fine sutures to the mucous flap with the opening of the ureter against the mucous mem-

\* I am much indebted to Dr. George W. Wheeler, Superintendent and Dr. V. F. Marshall, and Dr. John B. Pastore, Assistant Superintendents of the New York Hospital, as well as to Dr. Walter C. Klotz, Director, and Dr. H. J. Truax of the Out-Patient Department, for their generous help in furnishing the New York Hospital records of Walsh.

brane; the laying of the ureter on submucosa above the flap and securing it there with fine sutures. The peritoneal and muscular coats were then sutured over the ureter. No drainage was used in relation to the ureteral implantation but three cigarette drains and a rubber tissue drain were used to drain the pelvis on the left side where there had been much dissection and manipulation. The operation was necessarily a long one taking over two hours. The abdominal wound was closed without drainage; the drains emerged from the excised opening of the fistulous tract. The after course was uneventful. The sutures and all drains were removed on the sixth day and the patient was discharged on the thirteenth day with a healed wound and much improved. There was immediate control of rectal urination and defecation, urination occurring about every six hours per rectum and bowel movements twice daily.

From May 11 to May 24, 1940, there were five office dressings for a small superficial granulating area which had been scabbed over. The wound has remained completely healed since. For the next month there was slight pain occasionally in the left kidney region. The bladder and rectum functioned well. He gained steadily in weight and on January 1, 1941 weighed 179 pounds, a gain of 37 pounds.

On November 13, 1941 he reported that he worked all day and had no pain. He has gained more weight, passes water from rectum four times a day separately from two to three bowel movements; he has to get up occasionally at night when a good deal of fluid has been taken but he has complete control.

He does not find it necessary to pass urine by rectum at the same time that he passes urine by urethra. The controls are entirely independent. This is rather interesting. I have asked him to measure the amount of fluid which he passes by rectum and also the amount of urine which he passes by urethra. He states that the amount of urine by urethra in twenty-four hours is 32 ounces, that the amount of urine per rectum separate from the bowel movements is approximately 32 ounces.

Intravenous pyelogram on October 27, 1941, and plates taken May 15, 1942, at five, fifteen and twenty-five minute intervals showed good function in both kidneys and a normal right urinary tract. The left tract showed a moderate dilatation of the ureter and pelvis, without evidence of obstructive lesion, kinking or

otherwise. The left half of the bladder showed a deformity.

G. R. Fowler's next published contribution on implantation of the ureter into the rectum in exstrophy of the bladder was in the American Journal of the Medical Sciences, March 1898, in which he called attention to the unsatisfactory character of the results following operations designed for the restoration of the anterior bladder wall in exstrophy, such as introduced by Dr. Daniel Ayers and the further closure of the accompanying gap in the symphysis after the manner of Trendelenburg.

Konig and Kuster modified Trendelenburg's procedure by substituting osteotomy of the anterior pelvic ring for forced separation of the sacro-iliac junction. All of these procedures are difficult of execution.

Passavant proposed to accomplish closure of the pelvic bony gap by force brisement. C. T. A. Koch, of Growigen (Netherlands), carried out Passavant's proposition in a child of six years and six weeks later closed the defect in the soft parts by suture, reporting the case one week following the second operation.

In 1897, Tietze, of Mikulics Clinic, advised that all attempts to close the bony defect be abandoned and advocated closure by lateral flaps.

Even when exstrophy and the accompanying epispadias were corrected the patient's condition was not greatly improved. Attempts to restore the muscular apparatus of the vesical neck proved unsatisfactory, incontinence persisted, necessitating the wearing of an apparatus difficult to adjust and keep clean.

For these reasons Maydl, in Prag, in 1896, suggested implantation of the ureters into the rectum. This did not meet with marked favor on account of the probability of renal infection. That this fear was not theoretical was proved by clinical experience as well as by the experimented work on animals by Gluck and Zeller, Bardenheuer, Tuffier, Smith and others. These

clinical and laboratory results led to attempts to improve the technique of implantation to prevent renal infection through the open ends of the ureter in the rectum.

Four operative procedures were presented: The first, that of Maydl, had as its basic principle utilizing nature's arrangement of the *oblique* course of the ureter in the bladder wall and the arrangement of the mucous membrane at the vesical opening of the ureter, so Maydl transplanted the bas fond and ureters into the rectum.

Second, Krynski, operated according to the Maydl method on a twenty-three year old man with ectopia vesicae with an excellent result eight months postoperatively. Subsequent to this, in 1896, using dogs, he implanted the ureters into the *submucous connective tissue* space of the rectum by turning back a triangular flap of rectal wall in a lateral direction down to the mucous membrane, implanting the ureters there and making a small opening in the mucous membrane for the passage of urine, then suturing the triangular flap back in place. Krynski's operation is very ingenious and deserves a full description. He operated upon dogs. He never did the operation on man. He did not observe inflammation of the ureter or kidney to follow. His method is illustrated by three line drawings. A triangular incision is made through serosa and muscularis, reflecting the flap thus outlined, and then making an opening through the mucous membrane near the lower point of the triangle, and securing with four sutures the cut ureter with the intestinal wall in the opening, mucous membrane to mucous membrane, finally covering the implanted ureter with the reflected serosa-muscularis triangle and sewing the same in place, the long side with a continuous suture, the short side with individual sutures, two in the intestinal wall and two in intestinal wall and ureteral wall. The ureter is still further secured by suturing it with several interrupted stitches to the

intestinal wall. Krynski advises not to sew the reflected flap too tightly over the ureter to avoid constriction of its lumen.

Third, Vignoni, in 1895, on the basis of animal experimentation recommended a v-shaped flap cut from the anterior rectal wall, suturing the ureters upon this and covering them by suturing over them two lateral folds of the bowel wall.

Fourth, Pisani, operating on two dogs in 1895, transplanted part of the bladder wall with the ureter to the *posterior* wall of the rectum by an incision through the anterior rectal wall, removing a portion of the rectal mucous membrane from the posterior rectal wall and suturing the transplanted bladder wall and ureters to this freshened area. The remainder of the bladder was excised. One dog died of shock in sixty-two hours, the other of peritonitis after six days.

Fifth, G. R. Fowler, September 20, 1896, used the operative technic which was described at the beginning of this presentation and which was an original method.

The advantages claimed for this method of operating are as follows:

"1. An efficient permanent valve, with a mucous surface applied to the open mouths of the ureters, is provided. This valve is so situated that it is closely applied to and occludes the open ends of the ureters as the rectum becomes filled with urine, or when fecal matter descends from above.

"2. Placing the ureters in the *submucous space of the rectal wall* for a distance of three or more centimeters above the point where these enter the cavity of the rectum affords an additional safeguard against renal infection. In this situation the circular muscular fibres of the bowel wall compress the ureters and secure occlusion at this point during the act of defecation."

We next find G. R. Fowler's case referred to in his "Treatise on Surgery" in 1906. Unfortunately, the illustrations were not copied correctly from the originals appearing in the American Journal of the Medical

Sciences in 1898, the difference being that the dotted line showing the mucous membrane flap extends into the upper half of the diamond shape area whereas the flap in the original illustration is entirely in the lower half.

G. R. Fowler also failed to include the important observation made in the original report, "*Placing the ureters in the submucous space for a distance of three or more centimeters above the point where these enter the cavity of the rectum affords an additional safeguard against renal infection.*" I call attention particularly to this observation.

Probably the most complete study of transplantation of the ureters into the large intestine was made by Robert C. Coffee of Portland, Oregon.

Many of Coffee's articles later appeared, approximately fifteen in number, through the years 1929 to 1933 in various magazines. W. J. Mayo, in 1908, advised Coffee to take up the study of problems connected with pancreatic surgery. His dissection of the entrance of the common duct into the duodenum and the knowledge acquired in this manner caused him later to apply similar principles to transplantation of the ureters into the large intestine. He reviewed approximately 250 articles dealing with experimental attempts, and states that up to 1909 not one author had constructed a tru-non motile valve such as exists in ordinary mechanics or in the cardiovascular system at the mouth of the ureters or at the mouth of the bile duct.

The first operation cited by Coffee is that of Dr. G. R. Fowler, but unfortunately Coffee apparently got his information in regard to the Fowler operation through Fowler's "Treatise on Surgery" from which he quotes and reproduces illustrations. Had he gone further back to Fowler's original article in the American Journal of the Medical Sciences, he would have found that the original illustrations showed more clearly what the operation was and that Fowler's operation did include the

very principle which Coffee advocated as the underlying principle of successful ureteral implantation. Nor does Coffee describe the original procedures of Madyl, Krynski, Vignoni and Pisani.

Coffee gives deserved credit to Franklin H. Martin and shows very beautiful illustrations of the Martin operation. He also describes the Peter's operation. The history of his own procedure and the method of its performance is well described.

Briefly, these three operations, Coffee's, Martin's and Peter's are as follows:

*Coffee's operation* as done by Charles Mayo has already been described. As done by Coffee it is much more complicated and includes elements which are undesirable as inflicting too much injury on the ureter and so interfering with its physiological action.

John William Draper and William F. Braasch who writing on the "Function of the Ureterovesical Valve," stated that

"With few exceptions, all efforts to utilize the septic bowel as a urinary reservoir have signally failed. Has this been because of the destruction of the uretero-vesical valve alone? This has been the general opinion in the past. Has not the physiologic element in connection with this problem been overlooked? If it be true that nature has provided an abundant 'factor of safety' in combining both physiologic and mechanic factors in protecting against reflux, then it may be that the failure to make a vicarious bladder out of the bowel has been due to the destruction of the mechanic protection, coupled with such serious impairment of the physiologic defense as entirely to overbalance the 'factor of safety.' Such physiologic impairment may well be accomplished by the injury to the ureter consequent to its transplantation. Dudley Tait may be quoted as saying that the explanation of the recent occasional success of the ureteral rectal implantation should be attributed to the careful protection of the ureter from traumatism by the modern technic. This has been accom-

plished by discontinuing the use of a permanent catheter after transplantation and by minimizing the number of stitches taken in the ureter. This is directly in line with the idea that reflux is prevented much more by the ureter itself than by the obliquity of its valve. Tait also holds that the importance of the mechanic action of the valve in preventing reflux has been exaggerated.

"This consideration calls to mind the history of the patients in whom a mechanically corresponding valve, that situated at the papilla of Vater, was slit in the transduodenal operation of McBurney for the removal of gall-stones. This operation was done many times and, so far as is known, without grave injury to the patient by reason of reflux of duodenal contents into the common bile-duct, liver, or pancreas. It would appear, therefore, that the destruction of this mechanic safeguard must have placed the work of preventing such reflux on the physiologic function of the duct. This implies that the 'factor of safety' regarding the prevention of reflux into the liver as well as into the kidneys is in each case a double one, formed by a combination of a mechanic valve and a physiologic contrivance.

"Physiologists and anatomists alike, while universally drawing attention to the fact that the mechanic arrangements for the valve are such as to protect the ureter from the transmission of intravesical pressure, do not state that this is its solitary function nor do they summarize the conditions which would be obtained if the valve were destroyed. Here we are on the borderland between surgery and physiology and evidently at a point where the first cannot safely advance except through the help of the second. Have we not, in considering the ureteral valve as the paramount protector of the ureters and kidneys from dangers arising from below, been somewhat biased because of having reasoned from a morphologic point of view alone? Have not the underlying principles of physiology and chemistry

been overshadowed and forgotten in the tacit acceptance of this purely morphologic explanation? Indeed, it appears to us that the well-known difficulty of reproducing in animals the analogues of human disease, even though all the evident morphologic and physical conditions be duplicated, should suffice to show us that in the discussion of this as well as of other surgical problems, in considering form alone surgeons have as yet taken only the first primitive step. Were we to attempt to reproduce the ordinary symptoms of human disease in healthy human beings we should without doubt be confronted with the same difficulties that are encountered in making these attempts on animals.

"With these considerations in mind, and believing that the existing surgical studies of the ureteral meatus had been too closely on morphology, since the delicate physiologic regulation both as regards protection from ascending infection, if indeed any such process is possible, and as regards the maintenance of normal glomerulotubular pressure, had all been lost sight of, we made efforts to consider the bearing of these points in our experimental work. We did not expect to answer these questions by any single experimental study, but we hoped to make the subject somewhat clearer and to direct attention to the importance of physiology to applied surgery. We slit the valve in dogs in the belief that the ureter was much more than a mere aqueduct for the conduction of urine, and that the generally recognized check-valve action at the meatus was of contributory rather than of paramount importance. We have been led to believe as a result of these studies that, provided the physiologic and chemic balance of the organism and of the ureter were left intact, the importance of the mechanical action of the valve was correspondingly diminished and that its loss would usually be compensated for by the ureter. These ideas are not original, being simply the natural outcome of an application of mod-

ern physiology to the study of surgical problems.

"Cathelin's views as to the valvular function are pointed. In a paper on the mechanism of the ureteral ejaculation, Cathelin says that the meatus does not open after the manner of a sphincter—that there is not the least suggestion of force or contraction. He regards the opening of the valve as purely passive in character, likening it to the opening and closing of the mouth of a fish."

I cite the above to show the importance of correlating physiology as based on physics and chemistry as well as anatomy in the study of surgical problems such as the one under present consideration.

*Martin Operation.* The intestine is split down to the muscular coat, a stab wound made through the muscular coat and mucosa near the lower angle, the two ureters being drawn into the lumen of the intestine. Ureters are anchored to the inside of the intestine by suture; muscle wall is enfolded around the ureter. Muscular wall is made to envelop ureters for most of the length of the wound, peritoneum being closed over other sutures. The completed operation shows the ureters surrounded by muscle wall.

*Peter's Operation.* This consists of the transplantation of ureters into the rectum by the extraperitoneal method. The ureter is transplanted with rosette of bladder mucous membrane and muscle; the catheter is stitched into the ureter and protruded through the anus.

The indications for implantation of the ureter in the intestine are: (1) Incurable carcinoma of the bladder, urethra, or prostate for palliative purposes; (2) advanced carcinoma of the bladder, urethra, or prostate in which it is impossible surgically to remove the growth, but in which it is possible with the use of large and even ruthless doses of radium to destroy the growth; (3) early curable carcinoma as an essential part of the operation of total cystectomy, which may include prostatectomy in the male or

hysterectomy in the female; (4) carcinoma involving the urethra; (5) incurable vesico-vaginal fistula; (6) contracted bladder due to scars of ulceration or to other causes; (7) extensive, incurable, multiple perineal fistulas resulting from various causes; (8) tuberculous ulceration of the bladder in which one kidney remains good and the other is to be removed; (9) traumatic injuries which make the use of the bladder impracticable, and (10) exstrophy of the bladder. And to these we add intractable ureteral fistula in which destruction of the ureter is so extensive as to make plastic restoration or bladder implantation impracticable.

#### CONCLUSIONS

Any method of implantation to be functionally successful must: (1) Place the ureter in the intestinal wall in the submucous connective tissue for a sufficient distance for it to be compressed in its course thereby by intra-intestinal pressure while the bowel is acting. (2) Inflict the minimum amount of traumatism to the ureter in the operative procedure to prevent physiologic impairment. (Use few and fine sutures, avoid compression, expose the ureter as little as possible, be gentle.) (3) Avoid kinking to prevent undue obstruction. (4) Cut the ureter obliquely to avoid undue contraction which occurs when any transverse section is made in any tissue. (5) Face the ureters to mucous membrane to minimize forcing of fecal material into them.

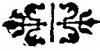
G. R. Fowler's operation embodied all of the factors except kinking which in some cases is unavoidable if the more important factor of inflicting the minimum amount of traumatism is strictly observed.

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PROPHYLAXIS requires a thorough debridement of all compound fractures, including radical wound excision when there is extensive laceration or contusion of the tissues. Every puncture wound should be decidedly enlarged. Such treatment has greatly reduced the incidence of gas infection.

# KNEE JOINT ARTHROTOMY IN MILITARY LIFE

CAPT. BYRON B. KING, M.C.  
Station Hospital, N.O.P.E.  
NEW ORLEANS, LOUISIANA

FIFTY arthrotomies of the knee joint were done during a six and one-half month period at the Station Hospital, New Orleans, Louisiana. This communication consists of a study of these cases. Follow-up and end result studies are not feasible in military life, so our observations have been confined for the most part to the periods of hospitalization of these men.

The majority of these arthrotomies were done because of medial meniscus pathology. Brantigan and Voshell<sup>1</sup> have pointed out that the menisci fill an otherwise dead space between the periphery of the condyles of the tibia and femur, and keep the capsule and synovia from becoming pinched between the femoral and tibial condyles. The medial meniscus is more often injured than the lateral, as it is more vulnerable to traumatizing forces which ordinarily affect a knee. The usual type of injury which traumatizes the medial meniscus consists of a sudden forceful abduction and external rotation of the leg on the thigh with the knee in partial flexion. Our patients experienced this by marching on uneven ground, doing about-faees, jumping over obstacle course hurdles, doing knee-bend calisthenics, falling down barracks steps, falling off trucks, crossing muddy streams, and playing football, baseball, and basketball.

Our operative preparation and technic was the same for all fifty cases. The entire extremity is shaved, washed with green soap and water, ether, 70 per cent alcohol, and wrapped in sterile towels twenty-four hours before operation. Spinal anesthesia (100 to 150 mg. novocain) is the anesthesia used. The leg is elevated for three minutes and an Esmarch tourniquet is applied. The extremity, from groin to toes, is painted with ether and then 3½ per cent

iodine. Sterile draping is facilitated by the use of a sterile stockinette, and a sandbag is placed under the thigh. A four or five inch vertical parapatellar incision one inch medial, or lateral, to the patellar border is made so that the joint line is at the level of the junction of its upper three-fourths and lower one-fourth. This proved to afford an adequate exposure of the joint. In two cases, through this single skin incision, a second vertical incision was made in the capsule posterior to the medial collateral ligament in order to remove the posterior portion of the medial meniscus. In one case the upper and lower ends of the incision were extended in a curved manner, thus converting it into the so-called utility incision. We condemn small incisions which do not give adequate exposure, since the entire joint should be thoroughly inspected. The infrapatellar branch of the saphenous nerve should be located and protected in order to prevent the annoying hypesthesia below the patella which follows its section. The capsule is incised vertically, but curving along the inner border of the muscle fibers of the vastus medialis (or lateralis) in order not to divide them. The capsule is divided vertically, and the interior of the joint is well exposed. If the medial meniscus is to be excised, a second sterile assistant standing caudad to the operator abduets and externally rotates the lower leg, and slightly flexes the knee. In ease the knee is being approached from its lateral aspect, the leg is adducted and internally rotated, and the knee is slightly flexed. The anterior half of the meniscus can be freed with a Bard-Parker type knife. For freeing the posterior half, we use a knife with a long narrow blade (two and one-half inches long

and one-eighth inch in width). These knives were made by simply grinding down ordinary dissecting scalpels. We believe that it is important to remove the meniscus in its entirety, and are not satisfied with excising just the anterior two-thirds or three-fourths. Two of our patients had previously had medial meniscectomies, but were not relieved of their symptoms. In both cases, the posterior portion of the meniscus was found to be present and was removed. Both original meniscectomies had been done through inadequately small incisions. Before closure, a fresh glove is slipped on and the anterior compartment of the knee, including the suprapatellar pouch and undersurface of the patella, is carefully palpated and inspected. The wound is closed in layers using continuous plain catgut for the synovia, continuous chromic catgut for the capsule, continuous plain catgut for the superficial fascia, and continuous silk for the skin.

If the signs and symptoms in a given case have warranted arthrotomy, and upon opening the joint the visible anterior portion of the meniscus appears normal, it is advisable to do a meniscectomy; otherwise tears or other lesions of the posterior portion will be overlooked in many cases. The day after operation, the circular gauze bandage is split vertically on the side opposite the wound in order to avoid any constriction, and an elastic roller bandage is applied over the split gauze bandage without disturbing the dressing. Assisted active motion of the knee, and quadriceps setting exercises for five minutes every hour, are begun at once. On the third or fourth day following operation, the patient sits up over the side of the bed in order to extend and flex his knee actively. One week following operation he becomes ambulatory without the aid of cane or crutches, and baking, massage, and active exercises daily are instituted. The use of a stationary bicycle machine, and extending the leg with the ankle strapped to a weighted rope and

pulley apparatus has greatly facilitated the return of quadriceps power.

During the six and one-half month period from August 24, 1942, to March 10, 1943, fifty arthrotomies of the knee were done. The youngest patient was twenty years of age, the oldest was forty-two, and the average age for the group was twenty-five. Thirty-three were in the second decade of life, thirteen were in the third decade, and four were in the fourth decade. Thirty-nine patients were white and eleven were colored, a ratio of 3:5 to 1. Forty-three meniscectomies were done; thirty-eight of these were medial meniscectomies, and five were lateral meniscectomies. Loose (osteocartilaginous) bodies were removed from five knees. Loosened, fibrillated articular cartilage was removed from the medial and lateral femoral condyles and patella in one knee, and in one instance a hypertrophied infrapatellar fat pad and regenerated connective tissue at the site of previous meniscectomies were excised.

Of the thirty-eight medial meniscectomies, twenty-one were done for well defined tears of the medial meniscus. These twenty-one were as follows:

	Cases
"Bucket handle" tear.....	8
Longitudinal tear of anterior $\frac{1}{3}$ .....	1
Longitudinal tear of middle $\frac{1}{3}$ .....	1
Longitudinal tear of posterior $\frac{1}{3}$ .....	5
Oblique tear of anterior $\frac{1}{3}$ .....	3
Oblique tear of middle $\frac{1}{3}$ .....	2
Oblique tear of posterior $\frac{1}{3}$ .....	0
Transverse tear of middle $\frac{1}{3}$ .....	1

Seventeen medial meniscectomies were done because of some type of disorder other than a tear. Two were discoid in their posterior halves. Two were the remaining posterior portions not removed at a previous arthrotomy through inadequately small incisions. In seven instances, there was a depression in the articular cartilage of the medial femoral condyle corresponding to the anterior portion of the medial meniscus with the knee in complete extension, and a pannus formation of the medial femoral epicondyle at this point.<sup>2</sup> One presented a

tear of the posterior half of the coronary ligament with displacement of its posterior end into the intercondylar notch. One presented a tear of the entire coronary ligament except at its anterior and posterior ends, and was found lying in an upside-down position. Three were hypermobile; the first was accompanied by fibrillation of the articular cartilage of the medial femoral and tibial condyles and patella, the second presented a bony spurring of the medial femoral epicondyle which was excised, and the third exhibited a small transverse tear of the middle one-third which may have been done in removal. One was accompanied by a cyst of the sartorius, gracilis, and semitendinosus tendon sheaths.

The anterior cruciate ligament was completely avulsed in the knee with the transverse tear of the middle one-third of the medial meniscus. This tear extended half the width of the meniscus, and was not inflicted during the meniscectomy. This patient had sustained a severe injury when "clipped" from the side while playing football. The synovial fluid was grossly bloody and increased in amount. The osteocartilaginous loose bodies varied in size, the largest being one inch by three-fourths inch by one-half inch in size. This particular loose body was removed from the posterior compartment of the knee through a midline posterior incision. One medial meniscus, which presented an oblique tear of its anterior one-third was markedly degenerated, and about one-third its normal width. Numerous small bits of cartilage, apparently arising from the degenerated meniscus, were floating free in the synovial fluid.

Forty-seven of the fifty patients gave a history of injury which was associated with the knee disability. In fifteen instances, this had occurred prior to entry into military service, but these men were unable satisfactorily to continue with their drilling, marching, and calisthenics. In twelve instances, there had been a previous injury in civilian life, followed by another injury in military life. In twenty instances, the

initial injury was sustained while in the service. Thirty-four patients gave a history of a single injury, while sixteen gave a history of two or more injuries. All patients, with but two exceptions, who had medial or lateral meniscus disturbance localized their pain to the inner or outer aspect of the knee. The five patients with loose bodies noted diffuse, rather than localized, discomfort or pain. The commonest symptoms complained of were instability of the knee or uneven ground or stairs, actual giving way, temporary locking in partial flexion, swelling, and "snapping" or "clicking" upon flexion and extension. The commonest signs elicited were tenderness over the joint line (in cases of meniscus disorder), effusion, varying degrees of limitation of extension and flexion, and muscle spasm at the extremes of motion. Knees with medial meniscus lesions usually presented pain about the medial aspect of the joint upon forced extension, adduction, and external tibial torsion. The five knees with lateral meniscus lesions (all cysts in this series) presented pain about the lateral aspect of the joint upon abduction and internal tibial torsion, as well as discomfort upon the extremes of extension and flexion. Three of the five cysts of the lateral meniscus were large enough to palpate prior to operation. Atrophy of the calf was noted in some cases of longer duration. Anteroposterior relaxation was evident in the knee with the avulsed anterior cruciate ligament. Palpable loose bodies, which would disappear into the interior of the joint upon flexion and extension, were noted in two cases.

Fifty-one incisions were made in the fifty knees. Forty-seven wounds healed per primam, two wound edges separated and healed by secondary intention, and one became infected. The offending organism in this case was *Staphylococcus albus*; this occurred in the second patient operated upon, and it is believed that this was an air-borne infection, although this of course cannot be proved. Thirty-three men have returned to duty, while seventeen are still in the hospital. The average period of

hospitalization of the thirty-three who have returned to duty was 40.3 days. The shortest period of hospital stay was seventeen days, and the longest was seventy-two days. Seven men were recommended for reclassification for limited service, and a furlough was recommended for three men.

The findings at operation were of particular interest in five patients. These will be briefly described.

**CASE I.** J. W. T. This thirty-one-year-old white soldier, who sustained a tear of his right medial meniscus in June, 1942, underwent a right medial meniscectomy in July, 1942, before being transferred to this Command Area. A small two-inch incision had been used. His pain, instability, and "snapping" were not relieved. On October 12, 1942, three months following the original arthrotomy, the right knee was explored through an adequate five-inch median parapatellar incision. The posterior one-third of the original medial meniscus was found still to be present and abnormally mobile. Upon flexion of the knee, it was observed to become displaced toward the center of the joint; it was excised. In the space formerly occupied by the previously extirpated anterior two-thirds of the meniscus, there was noted a small regenerated meniscus which consisted of a thickened and fibrosed invagination of the synovial membrane. This three-month-old rudimentary meniscus arising from an infolding of the synovia along the joint line was excised and sent to the pathology laboratory. Microscopic examination revealed it to consist of fibrous connective tissue, although grossly, except for its smaller size, it appeared quite similar to a normal meniscus.

The subject of regeneration of menisci following meniscectomy is one which had provoked considerable interest. Several investigators<sup>3,4</sup> have stated that the synovial membrane is the source of the regenerated menisci. Using dogs as experimental animals, Don King<sup>5</sup> observed a regeneration of fibrous tissue in meniscectomized knees. Gibson<sup>6</sup> reported a regenerated meniscus which revealed dense fibrous tissue microscopically, but no cartilage cells; the original meniscectomy had been done two months before the second arthrotomy. In our own case, the small regenerated meniscus definitely arose from an invagination of the synovial membrane filling the dead space left

after meniscectomy. Apparently a metaplasia of the synovia into fibrous connective tissue had occurred.

**CASE II.** A. J. C. This twenty-three-year-old white soldier gave a history of aching and discomfort about the lateral aspect of his left knee associated with a gradually progressive limitation of flexion. Examination revealed a tender cystic mass overlying the lateral aspect of the joint line. Flexion was limited at 90°, and three-fourths inch atrophy of the calf was observed. On November 27, 1942, the left lateral meniscus was excised. There was a large multiloculated cyst one and one-half inches by one and one-fourth inches by one inch in size arising from its periphery at the midpoint, which was lined by a smooth membrane and was filled with thick gelatinous material. A well defined pressure erosion of the lateral femoral condyle, lateral tibial condyle, and fibular head was evident; roentgenograms of the knee taken prior to operation had also revealed this. A full range of motion resulted.

**CASE III.** M. W. C. This thirty-year-old soldier wrenched his left knee playing football in 1932. Two weeks prior to admission, as he was doing vigorous deep knee-bend calisthenics he experienced a sudden sharp pain on the inner side of the knee, and was unable to extend it fully. Arthrotomy on November 30, 1942, revealed the medial meniscus to be attached only at its anterior and posterior extremities. The coronary ligament was completely torn except at these points, and the meniscus was lying in an upside-down position, having rotated through an arc of 180°. Meniscectomy resulted in a normally functioning knee.

**CASE IV.** V. E. Van W. This twenty-four-year-old white soldier pivoted on his left foot while playing an authorized game of basketball on November 14, 1942. He sustained acute pain about the inner side of the left knee which gave way, causing him to fall to the floor. Nine days later, his knee again gave way, and he fell to the floor, landing on his left patellar region. Thereafter, he was unable to flex the knee beyond 135°, preferring to hold it in full extension. Arthrotomy on December 7, 1942, revealed bloody synovial fluid in excessive amount. The posterior one-third of the coronary ligament and posterior attachment of the medial meniscus were torn, and the posterior extremity of the meniscus presented itself in

the intercondylar notch. A bony fragment one-half inch by one-half inch by three-eighths inch in size had been fractured from the inferior pole of the patella. This and the meniscus were excised. Following operation, a full range of free motion ensued.

CASE V. A. A. L. This twenty-nine-year-old white soldier severely wrenched his left knee sliding into base while playing an authorized game of baseball on December 18, 1942. Thereafter it became swollen, painful, and unstable. "Snapping" and "clicking" were complained of. Arthrotomy on February 22, 1943, disclosed an oblique tear of the anterior one-third of the medial meniscus. The torn portion, still attached to the anterior extremity of the meniscus was crumpled up into a hard mass one-half inch by one-fourth inch by three-eighths inch in size. It had apparently impinged between the articular surfaces upon motion of the knee, as there was a groove one-eighth inch wide and nearly that deep gouged out of the articular cartilage of the medial femoral condyle; this groove was one and one-half inches in length, and coursed in an antero-posterior manner along the long axis of the condylar surface. Two similar small grooves had been gouged out of the corresponding articular surface of the medial tibial condyle, and the articular cartilage of the inferior pole of the patella was fibrillated. The medial meniscus was excised.

#### CONCLUSIONS

A résumé of fifty arthrotomies of knees of soldiers has been presented. Thirty-eight medial meniscectomies were done; twenty-one of these were for tears of the medial

meniscus. Five lateral meniscectomies were done for cysts of the lateral meniscus. No tears of the lateral meniscus were encountered.

It is strongly believed that if an arthrotomy is indicated, an adequately large incision should be made and the joint thoroughly explored. It is also believed that if a meniscectomy is done, the entire meniscus should be removed. Quadriceps-setting exercises and assisted active motion on the first day after operation, and unassisted walking by the seventh day following operation, will hasten convalescence, and prevent quadriceps atrophy and weakness.

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Since this paper has been prepared, thirty-three additional knee joint arthrotomies have been done. Two tears of the lateral meniscus were encountered. They were oblique tears of the middle third.



## FURTHER EXPERIENCE WITH PILONIDAL CYSTS AT FORT SILL, OKLAHOMA

FORT SILL, OKLAHOMA

**O**F impelling interest to the surgical departments of our Army hospitals is the continued appearance of the many soldiers for treatment of pilonidal cysts, sinuses and their complicating infections and abscesses. This condition is possibly due to the many hours spent by troops sitting on the hard wooden seats of benches and trucks, in tanks, jeeps, and saddles. This is an educated Army, so the men at a post like Fort Sill spend long periods of each day seated in class at school. This is also a mechanized war, so the men may be seated in vehicles of many types during the greater part of their time.

In addition, at Fort Sill, the home of the Field Artillery School, many physical examinations are done upon Officer Candidates. If a pilonidal sinus, evidenced by presence of a tumor mass or discharging sinus, is discovered, the man is usually informed that this condition must be remedied before he can enter the school. After the course of study is finished, another physical examination is done, and at this time a few more disqualifying cysts or sinuses may be discovered. These men, too, must submit to operation before being commissioned. This adds to the usual number of ordinary symptomatic cases coming in for operation.

It is agreed by all that complete excision of a pilonidal cyst, with all its sinuses and branches, is the prime requisite in its cure. However, disagreement enters as to how best to take care of the wound from this point on. The variety and number of procedures advocated is mute testimony to the fact that there is no one single perfect plan. It will readily be seen that variations in the size, shape, location and condition of these cysts as well as in the individual

reaction of the patient, play a part in determining what should be done in any given case. Toward a solution of this problem are the following further experiences recounted:

## OPEN PACKING

In a previous article,<sup>1</sup> we reported our experience with this type of management. The average length of postoperative hospitalization was twenty-six days, varying in extremes from seven to fifty-eight days. Peculiarly enough, the discomfort suffered by these patients seems to be much less than that among civilians. Also, many men have been sent to full duty quite early with moderate sized wounds, requiring only a daily bath and a simple dry dressing. The use of sulfanilamide powder dusted into the wounds every two or three days seems to have been of some help in preventing or combatting secondary infection. This much may be said for the method, however, that it is one sure way of obtaining complete cure of the pilonidal cyst when the time factor is not considered too important.

## PRIMARY CLOSURE

The treatment of small, uninfected, asymptomatic pilonidal cysts or sinuses can usually be carried out surgically, as with any dermoid or sebaceous cysts elsewhere in the body. The cyst can be excised and the wound closed primarily, being careful to obliterate the dead space by using a figure-of-eight retention suture tied over a piece of gauze. We have done this on three occasions in the past few months with primary healing resulting. The patients did not suffer any postoperative pain or discomfort to speak of. Table I shows the pertinent features of these four cases.

It will be noted that the men were kept in the hospital two to three weeks post-operatively, which seems an unusually long period—and it is. They could all have been

or later when cleanly granulating, would be given. In this connection, two important factors had to be given consideration: (1) maintenance of a clean wound, and

TABLE I

Name	Size of Cyst	Date of Operation	Size of Original Wound	Date	Postoperative Days at Hospital	Primary Healing
King, S . . . . .	Small	8-28-42	?	9-16-42	19	Yes
Robinson, R . . . . .	Moderate	10-19-42	2 X 1 in.	11-2-42	14	Yes
Brown, H. . . . .	Small (1 X 1½ in.)	11-2-42	1 X ½ X ½ in. deep	11-17-42	15	Yes
Huitt, E. . . . .	Moderate	11-18-42	2 X 1 X ½ in.	11-28-42	11	Yes

discharged after a few days, but were not sent out for two reasons:

1. We wished to make sure personally that healing was complete, that the wounds did not become infected secondarily, and that they did not open later. We are satisfied that if the silk sutures used are left in eight to ten days and the gauze pack kept in place with the retention suture that length of time, the wounds will heal cleanly and kindly.

2. The second reason for keeping these men in the hospital for this prolonged period is that all three of them were in the Officers Candidate School. This is a very hard course, with long periods of work in class and activity in the field. It is a course in which even a normally healthy man is put to the test. Then, too, there were administrative factors which kept a man in the hospital several, or many, days after he was ready for discharge, such as the waiting for the next class to start, and it was thought that the man was better off under direct observation than marking time in his quarters.

#### SKIN GRAFTING

Upon the suggestion of Lieut. Colonel B. L. Coley, in order to cut down the time for complete epithelialization, a trial at skin grafting of wounds in uninfected cases, at the time of the original excision,

(2) adequate pressure upon the skin-grafted area.

The unsanitary condition of the region with which we are dealing, between the nates and close to the anus, obviously makes the taking of skin grafts precarious. The site of the pilonidal cyst and, therefore, the excised wound, varies with each individual. If it is high up over the flat surface of the sacrum, one has an admirable site for obtaining even, continued and optimum pressure. If, however, the cyst is located low over a mobile coccyx, or laterally in a fatty buttock, or worse still, over the postanal musculature, the problem of securing adequate and continued pressure dressings for four to seven days is a difficult one.

However, in two instances of grossly uninjected cases, skin grafting was undertaken. (Table II.) In the first case, a large cyst was excised, with a resulting oval wound 4 inches long and 2½ inches wide. The skin was sutured down to the deep fascia, resulting in a wound 3 inches by 1½ inches. Eighteen pinch grafts were then taken from the thigh and applied with a sponge rubber pressure dressing. Most of the grafts took, but when the patient was discharged thirty-four days later, there was still a small granulating area, which took several weeks more to close. The second case was a smaller cyst

1½ inches long. After excision and suturing down of skin edges, a wound resulted needing only six small pinch grafts for covering. These did not all take, and at the time of discharge from hospital, fifteen days later, a small granulating wound was still present.

for the final operation has been most satisfactory in practically all cases, using 100 mg. of novocaine crystals dissolved in 2 cc. of spinal fluid. A block dissection is done with excision of all side tracts. This usually leaves a large gaping wound. Hemostasis is secured with fine plain

TABLE II  
SKIN GRAFTING

Case	Size of Cyst	Date of Operation	Size of Original Wound	Size of Partial Closure	Size at Discharge	Date of Discharge	Postoperative Days in Hospital	Date Closed Approx.	Days Till Closed
1	Large	8/26/42	4 × 2½ inches oval	3 × 1½ inches	Very small	9/29/42	34	10/10/42	45
2	1½ inches long	9/7/42	1½ × 1 inch	1 × ½ inches	Small	9/22/42	15	10/6/42	29

These two cases turned out successfully, but were carefully selected for trial of this method. For the much extra time and effort spent in operation and after care of the patient by one "sympathetic" to the method, it could be seen that the healing time was not much shortened. Further, it is probably applicable to only a few of the patients.

#### PRIMARY PARTIAL CLOSURE BY SUTURE OF SKIN TO FASCIA

A logical outcome of these experiences seemed to be a compromise between complete open packing of the wound and complete primary closure. Accordingly, primary partial closure of the wound by suture of the skin edges to the deep fascia and periosteum was given a trial. A brief description of our procedure similar to those of McFee,<sup>2</sup> and DePrezio<sup>3</sup> follows:

As clean a preoperative field as possible should be secured. If an abscess is present to begin with, it is drained, and the inflammation allowed to subside with warm moist compresses or sitz baths for five to ten days. If there is a draining sinus to start with, baths are given for a few days, and sometimes the cyst is also incised for better drainage. Spinal anesthesia

catgut ligatures. Sulfanilamide powder is sprinkled over the wound surface. Fine interrupted silk sutures are then used to tack the edges of the skin down to the deep fascia and periosteum covering the sacrum and coccyx. This procedure decreases the wound to about one-half its original size. A little more sulfanilamide is then dusted on and a vaseline pack applied with moderate pressure. This is left in place for about four days. The wound is dressed every two days after this by the medical officer, who sprinkles a little sulfanilamide powder on the wound at the time. Sutures are removed in six to eight days. Daily sitz baths are then started with the use of sterile dry gauze dressing after each one. No infections or abscesses under skin flaps have resulted. The men have a very comfortable post-operative period and are out of bed a few days after operation. Occasionally, touching up of exuberant granulations at the skin edge with a silver nitrate stick is necessary. The wounds have progressively closed with this regimen in from two to six weeks under our observation. In this group of cases (Table III) attention is again called to the prolonged postoperative hospital stay. This, as in the instances of

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primary closures, is due to our curiosity about the wounds, the question of development or not of infection, the amount of tension and cutting through of sutures, and the progress of healing, with or without sitz baths, sulfanilamide powder and the frequency of change of dressings.

The follow-up is not as easy as it would first seem. This Post has an ever changing personnel. Men are shipped out to other assignments directly from the hospital or a few days after their discharge. It should be noted, too, that not all subjects with similarly sized wounds heal and close

TABLE III  
PARTIAL CLOSURE OF SKIN TO FASCIA

Case	Size of Cyst	Date of Operation	Size of Original Wound	Size after Part Closure	Size on Discharge	Date of Discharge	Post-operative Days in Hospital	Date Closed Completely	Days Till Closed
1	?	9/1/42							
2	2 <sup>1</sup> / <sub>2</sub> inches long	9/14/42	3 <sup>1</sup> / <sub>2</sub> in. X 2 in.	3 in. X 1 <sup>1</sup> / <sub>2</sub> in.					
3	?	9/23/42							
4	1 <sup>1</sup> / <sub>2 inches dia. and deep</sub>	10/3/42	2 in. X 1 <sup>1</sup> / <sub>2</sub> in. X 1 in.	1 in. X 1 <sup>1</sup> / <sub>2</sub> in.					
5	1 inch dia	10/5/42	2 in. X 1 <sup>1</sup> / <sub>2</sub> in. X 1 in.	2 <sup>1</sup> / <sub>2</sub> in. X 1 <sup>1</sup> / <sub>2</sub> in.					
6	?	10/9/42	3 in. X 1 <sup>1</sup> / <sub>2</sub> in. X 1 in.	3 in. X 1 in.					
7	8 cc	10/14/42							
8	?	10/15/42	2 <sup>1</sup> / <sub>2</sub> in. X 3 in. X 1 <sup>1</sup> / <sub>2</sub> in.	2 <sup>1</sup> / <sub>2</sub> in. X 1 <sup>1</sup> / <sub>2</sub> in.					
9	?	10/17/42	4 in. X 3 in. X 1 <sup>1</sup> / <sub>2</sub> in.	3 in. X 1 in.					
10	?	10/12/42	2 <sup>1</sup> / <sub>2</sub> in. X 3 in. X 1 <sup>1</sup> / <sub>2</sub> in.	1 <sup>1</sup> / <sub>2</sub> in. X 1 <sup>1</sup> / <sub>2</sub> in.					
11	?	10/28/42	2 <sup>1</sup> / <sub>2</sub> in. X 3 in. X 1 in.	4 in. X 1 <sup>1</sup> / <sub>2</sub> in.					
12	?	11/4/42	3 <sup>1</sup> / <sub>2</sub> in. X 1 <sup>1</sup> / <sub>2</sub> in. X 1 in.	1 in. X 1 <sup>1</sup> / <sub>2</sub> in.					
13	?	11/7/42	3 <sup>1</sup> / <sub>2</sub> in. X 1 <sup>1</sup> / <sub>2</sub> in. X 1 in.	3 <sup>1</sup> / <sub>2</sub> in. X 1 <sup>1</sup> / <sub>2</sub> in.					
14	Long	11/9/42	3 <sup>1</sup> / <sub>2</sub> in. X 1 <sup>1</sup> / <sub>2</sub> in. X 1 in.	1 <sup>1</sup> / <sub>2</sub> in. X 1 <sup>1</sup> / <sub>2</sub> in.					
15	Moderate	11/23/42	3 <sup>1</sup> / <sub>2</sub> in. X 1 <sup>1</sup> / <sub>2</sub> in. X 1 in.	2 in. X 1 in.					
16	Large	11/20/42	3 <sup>1</sup> / <sub>2</sub> in. X 1 <sup>1</sup> / <sub>2</sub> in. X 1 in.	2 in. X 1 in.					
17	Moderate	11/23/42	2 <sup>1</sup> / <sub>2</sub> in. X 3 in. X 1 <sup>1</sup> / <sub>2</sub> in.	2 <sup>1</sup> / <sub>2</sub> in. X 1 <sup>1</sup> / <sub>2</sub> in.					
18	Moderate	11/27/42	2 <sup>1</sup> / <sub>2</sub> in. X 1 <sup>1</sup> / <sub>2</sub> in. X 1 in.	2 <sup>1</sup> / <sub>2</sub> in. X 1 <sup>1</sup> / <sub>2</sub> in.					
19	Moderate	11/27/42	2 <sup>1</sup> / <sub>2</sub> in. X 1 <sup>1</sup> / <sub>2</sub> in. X 1 in.	2 <sup>1</sup> / <sub>2</sub> in. X 1 <sup>1</sup> / <sub>2</sub> in.					
20	Moderate	12/1/42	2 <sup>1</sup> / <sub>2</sub> in. X 1 <sup>1</sup> / <sub>2</sub> in. X 1 in.	2 <sup>1</sup> / <sub>2</sub> in. X 1 <sup>1</sup> / <sub>2</sub> in.					
21	Small but deep	12/7/42	1 <sup>1</sup> / <sub>2</sub> in. X 1 in. X 1 in.	1 <sup>1</sup> / <sub>2</sub> in. X 1 in.					
22	?								
23	Moderate	12/14/42	1 <sup>1</sup> / <sub>2</sub> in. X 1 <sup>1</sup> / <sub>2</sub> in. X 1 in.	1 <sup>1</sup> / <sub>2</sub> in. X 1 in.					
24	Moderate	12/16/42	1 <sup>1</sup> / <sub>2</sub> in. X 1 in. X 1 in.	1 <sup>1</sup> / <sub>2</sub> in. X 1 in.					

The average length of postoperative stay in the hospital in this group of twelve cases was nineteen and one-fourth days. Three other patients, very recently operated upon, are not included in the above group. They could easily be discharged and sent to the dispensary for dressings, as were some of those original cases which were packed wide open to start with and sent to duty after eight to ten days' hospital stay postoperatively.

#### REMARKS

There are two or three further problems in this study which should be considered.

over at the same rate. There is a large variation, and this is especially true with the tendency to exuberant granulation, both clean and infected, to which this anatomical region seems to be subject.

Further, the question of recurrences cannot be completely settled at this early date. Probably six months after complete closure should elapse before one can say there is no recurrence only after thorough examination. Important, too, is the problem of the type of scar which results after each one of the procedures, whether it is tender, painful, friable, tough, comfortable and serviceable.

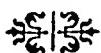
These experiences are merely those of one hospital for a period of fifteen months in only one field of a fairly busy surgical service. We wish it were possible to furnish more details and a more complete follow-up. Records of some cases are incomplete for all points which we now believe to be of importance for comparison. Seven different surgeons operated upon those patients. This made it difficult to standardize technic and to record all pertinent facts. A standard blank form for each case will probably yield this information for future reference and summary. We will also try to engage the interest of the eleven different dispensaries on this post in the postoperative care and records of these cases so that they may be followed to a shorter successful termination.

## CONCLUSIONS

1. The flap suture method with partial closure represents an advance in shortening the period of hospitalization.
2. The procedure of complete excision and packing represents a reliable method of management in the hands of the average surgeon when circumstances do not permit a selection of cases.

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## TENOSYNOVITIS\*

### AN INDUSTRIAL DISABILITY

JEWETT V. REED, M.D.

AND

ALLAN K. HARCOURT, M.D.

On staffs of the Methodist, St. Vincent's and  
Indianapolis City Hospitals

On staffs of the Methodist, St. Vincent's and  
Indianapolis City Hospitals

INDIANAPOLIS, INDIANA

WITH the speeding up of production in most types of work, it is obvious that it is the duty of the industrial surgeon to do everything possible to reduce disability in injured workmen. In order to test the efficiency of some of our methods of treatment, we are analyzing various groups of cases in order to determine whether or not our methods can be improved.

We have chosen the subject of tenosynovitis, a comparatively simple injury, but one that results in a great variation in length of disability. If we can determine why some patients recover in a few days while others are disabled for sixty days or more, apparently suffering from the same type and severity of trauma, we may be able to improve our method of treatment.

During a recent twelve-month period we treated seventy persons with a diagnosis of tenosynovitis, approximately .54 per cent of the total admissions for that period. The total time lost on account of disability of these seventy persons amounted to 1,222 days, or approximately three and one-third years, a rather surprising amount of time lost for a comparatively minor injury.

We divide our cases of tenosynovitis into three groups: first, those cases following strains of the wrist or ankle in which the tendons are overstretched; second, contusions to the tendons and sheaths, both of which classifications are considered as accidents; and third, a group which is becoming more common, in which irritation of the tendon and sheath follows repeated and rapid motion of the part, a condition which should be classed as an

occupational disease. The above three types of tendon insult may occur in tendons apparently normal, or they may be superimposed on a tendon or sheath which has some pre-existing abnormality, perhaps an abnormality that has been entirely free from symptoms until some trauma or irritation brings it to the patient's notice.

The pathological status of tenosynovitis has not been demonstrated as completely as many other conditions because we seldom have the opportunity to examine the affected parts unless they require exploration. It is easy to visualize, however, the pathological picture occurring in a contused or overstretched tendon in which a few fibers may be torn, the presence of minute hemorrhage, edema and exudation producing more or less local swelling. It is quite difficult, however, to visualize the changes which take place in a tendon or its sheath following rapid or repeated motions. Moritz<sup>1</sup> describes the work of Obolenskaja and Goljanitzki in which they found in experimental animals, fraying of the surfaces of both the tendon and its sheath, accompanied by edema and interstitial hemorrhage, following rapid, repeated motions of the tendon. These changes are probably the beginning of narrowing of the sheath or adhesions between the sheath and the tendon, which are found occasionally on exploration.

Howard<sup>2</sup> explored three cases of crepitating tendons in order to study their pathological status. He found that in certain cases of direct blows over the leg or forearm, a crepitating swelling appeared. Exploration showed a jelly-like edema

\* From the Indianapolis Industrial Clinic.

about the muscle-tendon junction, together with some muscle fiber degeneration.

The various latent abnormalities of tendons or their sheaths which may be aggravated by either trauma or repeated motions, are scar tissue changes, probably the result of previous injuries, and neoplasms. The scar tissue changes consist of slight swellings in the tendons, often accompanied by a constriction of the sheath at the corresponding level. Again, fibrous bands may form between the tendon and its sheath.

Tumors of the tendons and sheaths are quite rare. The most common of these is the fibroma, a true benign neoplasm. It may occur as a small round nodule on, or within, the tendon. A fibroma is not the result of trauma but it can become noticeable following trauma or excessive motion.

Some of the older texts describe tenosynovitis as being due to a "rheumatic condition." This may be true in some instances but we have never seen a case in which we could ascribe this etiology. It is possible, however, that a latent or cryptogenic infection, as of the teeth, sinuses, etc., might prolong recovery or even aggravate a traumatic tenosynovitis.

A ganglion of a tendon sheath does not properly come under the heading of tenosynovitis. Nevertheless, it is well to consider it at this point. We usually consider a ganglion as a hernial protrusion of the tendon sheath, a swelling which may appear spontaneously or may follow shortly after an injury. Pack<sup>3</sup> states that a ganglion is not a herniation of the sheath but is due to a fibroplasia and colloid degeneration which coalesce to form a cyst. Regardless of their pathology, we must admit that many ganglia follow trauma to the tendons of the wrist. There are a few other forms of tendon disorders that may be mentioned but which were not encountered in the cases under consideration. At times these must be kept in mind in making a differential diagnosis. There is the septic or pyogenic form of tendon sheath infection which follows infected wounds of the hands

or wrists. Rarely we encounter tuberculous tenosynovitis or gonorrhreal tenosynovitis, neither of which has any relation to trauma. The xanthoma is a nodular mass occasionally found on a flexor tendon of one of the fingers. It is a granuloma composed of various types of connective tissue cells intermingled with lipoid material. These growths are benign and it is questionable whether or not they are true neoplasms. Apparently they have no relation to trauma.

In the form of tenosynovitis under consideration, that is, those cases resulting from strains, contusions and repeated motions, pain, usually disabling, in the region of the affected tendon is the most constant feature. This is made worse on pressure over the part and also on using the member controlled by that tendon. Swelling of the tendon sheath can often be seen and palpated. It is unusual for the overlying skin to be reddened. In the majority of cases a tendon crepitation is marked and can either be felt or heard through the stethoscope. Occasionally, a clicking or snapping sensation is present as the tendon passes through its sheath. This is a most important finding. When it is present in an acute case it means that the abnormality has existed prior to the trauma, perhaps causing no trouble until aggravated by trauma or overuse. This clicking or snapping is the result of a scar tissue thickening or a fibroma of the tendon, usually associated with a constriction of the tendon sheath. Often these nodules and thickenings of the tendon can be palpated. In a few of our cases this clicking sensation was not present during the acute stage of the trouble but appeared later. This was probably due to an exudate within the sheath during the acute stage, which distended it to the point that the clicking could not be observed until after the acute symptoms had subsided.

The diagnosis of tenosynovitis offers no difficulty if one finds the clinical features enumerated above. That form of tenosynovitis following the excessive use of a

part has been confused with the so-called occupational cramps or palsies. The chief differential point is that in the case of an occupational cramp, the pain or disability occurs only when the patient is performing those motions required in his work. Making the same motions on examination causes no difficulty. In the case of tenosynovitis, the pain is present on motion under all conditions.

The treatment of acute tenosynovitis has been to put the part to rest by means of a plaster splint. This is removed about every second day in order to give the parts gentle passive motion to prevent stiffness, and also for the application of a diathermy treatment. After the acute symptoms have subsided, the patient is allowed to use the part for very slight movements only. When all pain has subsided the patient is allowed to resume his work gradually. Permitting patients to return to work too soon has been the cause of recurrence in several cases. When a clicking or snapping is noted, exploration is performed as soon as possible. When a distinct nodule is found, it is excised and the sheath repaired. When there is a fusiform swelling of the tendon with a constriction of the sheath, the latter should be "windowed" to allow free motion of its contained enlarged tendon.

In our present study of seventy cases of tenosynovitis, forty-four were attributed to strains, thirteen to contusions and thirteen to repeated motions, such as pushing material with the thumb and finger, repeated pressure on a part of a machine, turning screws, rubbing or polishing materials, etc.

The forty-four cases of tenosynovitis due to strain are distributed as follows:

Extensors of the wrist or fingers at the level of the wrist.....	32
Flexors of the wrist.....	2
Extensors of the thumb.....	4
Extensors of the index finger.....	2
Flexor of the index finger.....	1
Extensors of the toes.....	1
Tendo calcaneus.....	2

(While the tendo calcaneus does not possess a sheath, when strained and con-

tused it can produce the same clinical features as sheathed tendons. Even crepitation is generally present.)

Out of this group of tenosynovitis due to strains, two patients were operated upon.

#### CASE REPORTS

W. R., a male, age twenty-nine, strained his right wrist. After a few days the condition gave the appearance of a tenosynovitis of one of the flexors in the right wrist. With rest to the part the condition improved, but on returning to work the pain returned. Over a period of about three months he had thirteen days of disability and when working he had to limit his activities. During the fourth month following the injury a small nodule could be palpated on a tendon in the wrist proximal to the flexor retinaculum. This was explored and proved to be a true fibroma in the flexor indicis profundus tendon. Forty-four days following the operation he returned to work, free from symptoms. His long convalescence was occasioned by the necessity of severing the tendon and repairing it in the removal of the fibroma.

L. B., a female, age thirty, sprained the extensor tendons of the left thumb. She worked about one month without receiving treatment, and then splinting and diathermy treatment were used for fifty-six days with very little improvement and she was still disabled. On account of the persistent pain and tenderness, the tendon of the extensor pollicis brevis was explored. A constriction of the sheath was found distal to the annular ligament, with adhesions between the sheath and the tendon. The constriction was severed and the adhesions were broken up. The patient returned to work at the end of twenty-five days, free from symptoms.

The thirteen cases of tenosynovitis due to contusions can be grouped as follows:

Extensors of the wrist.....	8
Extensors of the fingers.....	2
Flexors of the fingers.....	2
Extensors of the ankle.....	1

Out of this group, three patients were operated upon:

F. L., a female, age thirty, had a contused flexor surface of the right wrist. She was given conservative treatment with short periods of

disability for about one year when a ganglion appeared over the flexor carpi radialis. Following removal of the ganglion she was able to resume work after thirty days.

J. W., a male, age thirty-nine, suffered a contused palm of the left hand. The diagnosis of tenosynovitis of the flexors of the left ring finger was made. After two weeks of conservative treatment there was no improvement. By this time the diffuse swelling which had appeared immediately after the injury, had subsided and a distinct nodule in the tendon could be palpated in the palm at the base of the finger. Exploration through the palm revealed a true fibroma of the tendon sheath, which was removed. The patient returned to work in thirty-five days.

P. J., a male, age thirty-three, contused and lacerated the palmar surface of the left wrist, the laceration not involving tendons or sheaths. Six weeks later he reported, complaining of a painful nodule in the tendon of the flexor carpi radialis in the middle third of the forearm. Exploration revealed a small true fibroma of the tendon, which was removed, followed by a relief of symptoms. He returned to work five days following the operation. In this case, in all probability the contusion brought to his attention the pre-existing fibroma.

The thirteen cases of tenosynovitis resulting from rapid or repeated motions are grouped as follows:

Extensors of the wrist or fingers at the level of the wrist.....	7
Extensors of the thumb.....	3
Flexors of the thumb.....	2
Flexor of the middle finger in the palm	1

Out of this group three patients were operated upon:

A. P., a female, age twenty-nine, for three months had used the right thumb to press an emery cloth against material in a lathe. Rather suddenly a trigger thumb appeared. Exploration showed a thickening of the tendon with a constriction of the sheath at the same level. Removal of the swelling on the tendon and leaving a window in the sheath relieved all symptoms. Microscopic study of the nodule showed scar tissue formation. One week of disability followed the operation. In all probability this condition was the result of irritation of the tendon and sheath from her occupation.

L. H., a female, age thirty-seven, complained of pain in the flexor surface of the right thumb following one month of work on an assembly line in which she constantly used the thumb, screwing caps on small shells. Examination showed a definite trigger thumb. Exploration revealed a bulging of the tendon with a constriction of the sheath at the level of the metacarpophalangeal joint. Part of the constriction of the sheath was excised, allowing free motion of the tendon. The patient was completely recovered fourteen days following the operation.

C. S., a male, age fifty, pulled trucks over uneven surfaces for six months. There appeared a gradually increasing pain in the palm of the right hand, increasing to the point of complete disability. Examination revealed a tender nodule in the palm, on the flexor tendon of the middle finger. Exploration showed a nodule on the tendon with adhesions to the sheath. The nodule was removed and showed microscopically to be a low grade inflammatory cicatrix. Postoperative disability amounted to twenty-eight days.

#### SUMMARY

In summarizing our seventy cases of tenosynovitis during a period of twelve months, we find that sixty-two patients were treated by conservative methods and eight were operated upon. Of the sixty-two nonoperative cases, disability ranged from none to sixty days, a total of 933, or an average of fifteen days disability per case. Of the eight patients operated upon, disability before operation ranged from none to fifty-nine days, or a total of 119 days. The postoperative disability in these cases totaled 170 days, or twenty-one days per patient.

While statistics prove little or nothing, our collected figures suggest an improvement in our procedure. In all of our operative cases except one, exploration was done on definite physical findings, namely, the presence of a nodule on the tendon or the snapping or clicking on motion. In one case (L. B.) conservative treatment was employed for fifty-six days, and as little improvement was obtained, the tendon

was explored, showing a narrowing of the sheath with adhesions. In reviewing our cases in which we used conservative treatment, we find fourteen cases with a disability of more than twenty days, giving a total disability of 542 days, an average of thirty-nine days per case. Therefore, with an average convalescence of twenty-one days, even if we found nothing on exploration, we would have added nothing to the period of disability. Again, on exploring those cases which did not respond to conservative treatment within twenty days,

we might find some organic condition that could not be determined on physical examination. From now on, we intend to explore all cases of tenosynovitis that do not show decided improvement within twenty days.

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THE prognosis of gas-bacillus infection depends upon the patient's resistance, the part of the body involved, the virulence of the organism and the treatment. The extent of operative treatment depends upon the severity of the individual case.

# ANISOAURIA IN CONGENITAL TORTICOLLIS\*

SIMON STONE, M.D.

MANCHESTER, NEW HAMPSHIRE

OCCASIONALLY considerable difficulty is encountered in younger children in differentiating the side which is involved in congenital torticollis. The maternal impression as to position of head and chin differs frequently from the position the head is held at the time of the examination. Also in children with short necks or in very young children, in whom poor co-operation makes careful examination difficult, the determination of the side affected becomes more of a problem.

Assymetry of face and skull, which appear smaller on the side of the shortened muscle, if present, gives valuable confirmatory evidence. Another sign which I found of definite value is the underdevelopment of the ear on the affected side. The involved ear in some cases is only two-thirds or less the size of the normal ear. The discrepancy in the size of the ears has been found often to exist in the absence of facial assymetry and in such instances was of additional diagnostic significance. A return to near normal size does occur after successful correction of the torticollis but in some instances the difference was observed to persist for several years afterward. Also hypertrophy and flaring out of the ear on the unaffected side was observed in rare cases, so that this ear appeared much larger

than the ear of a normal child of the same age.

The etiology is probably identical with the cause of the facial assymetry. Compression of the external carotid artery at the angle produced when the head is tilted to one side as a result of the torticollis has been suggested as one of the causes. A hematoma of the sternomastoid was found on examination in a number of our cases seen within a few weeks after birth and this was probably the immediate cause of the torticollis. It is possible, however, that the presence of antenatal fibrosis of the sternomastoid on the affected side was responsible for the tear of the muscle and production of the hematoma. The over-growth of the ear on the normal side, whenever present, is believed to be due to an increase in blood supply to the facial and occipital arteries on the non-affected side, and possibly is in the nature of a compensatory hypertrophy which is seen in paired organs when the function of one is impaired.

This note has been prompted by the failure to find mention in medical literature of the occurrence of this difference in size of the auricular appendages in congenital torticollis. The term anisoauria is suggested for this condition.

\* From the Department of Neurology, Elliot Hospital, Manchester, N. H., and the Crippled Children's Services, State of New Hampshire, Dr. Ezra A. Jones, Medical Director.



# Case Reports

## POTT'S DISEASE AFFECTING A SILENT AREA OF THE SPINE\*

### CASE REPORT

LIEUT. COL. BUFORD WORD, M.C.

Station Hospital

CAMP SHELBY, MISSISSIPPI

THE case herein reported is that of a diagnostic problem and demonstrates the difficulty of making the correct diagnosis when the lesion is located in a silent area of the vertebral column. No symptoms whatsoever were present, and the only evident physical sign is shown in the accompanying photograph. (Fig. 1.)

#### CASE REPORT

L. N. C., a Chinese male, age thirty-three, Hospital Register No. 15,583, was admitted to Station Hospital, Camp Shelby, Mississippi, August 15, 1941, with the chief complaint of swelling on the lateral surface of the left thigh.

The soldier stated that about July 15th, one month prior to admission, he first noticed a slight swelling over the lateral surface of the left thigh, at the level of the hip joint. No pain accompanied the swelling and no pain was noted on motion of his leg on the affected side. As his leg did not bother him, he paid no attention to the swelling. The tumor mass gradually increased in size until August 5th, about three weeks after onset, then suddenly began to increase rapidly in size, and continued to enlarge until he was admitted to the hospital. The soldier had no complaint other than the one described above; in fact he had no complaint—he "just thought something was wrong."

His past history revealed that in 1931 the patient was operated for ruptured peptic ulcer (note scar in photograph), no sequela. In 1938, he developed a primary penile lesion confirmed by a positive Wassermann reaction, and was treated continuously for eighteen months by hip and arm shots at weekly intervals. His

family history revealed nothing of note except that one sister was operated for "tubercular breast."

Physical examination on admission revealed a well developed and fairly well nourished Chinese male, blood pressure 100/66. The patient was ambulatory and afebrile. His only reason for presenting himself for examination was the formation of a symptomless tumor mass of the left thigh. Examination of head, including eyes, ears, nose, and throat, was non-revealing. Examination of the chest showed nothing of note. Except for a healed, firm, upper right rectus incision, the findings on abdominal examination were within the limits of normal. No tender areas were noted over any of the vertebrae and no tenderness was present in either flank or groin. On inspection of the lateral surface of the left thigh at the level of the greater trochanter, a large tumor mass was noted. It was about the size of a "volley ball" and on palpation was found to be fluctuant and non-tender. The mass did not appear to be attached to the skin or deeper structures. No induration was present surrounding the mass, and no evidence of inflammation could be detected within the mass. There was no pain on motion or limitation of motion of the left lower extremity. The external genitalia were normal in size and development. Rectal examination revealed no strictures or ulcerations and the mucosa appeared normal. The lower extremities were well nourished; no atrophy, paralysis, or any deformity was noted. The reflexes were normal, equal, and physiological.

Complete blood picture and urinalysis were within the limits of normal. Blood serology was

\* From the Surgical Service of Lieut. Colonel William C. Reed, M.C., Station Hospital, Camp Shelby, Mississippi.

positive on repeated occasions. Spinal fluid was normal. Repeated x-ray pictures of the chest and vertebral column were reported as normal.

On September 5th, the tumor was injected with 50 cc. of 5 per cent solution of sodium iodide and x-ray pictures were made. However, visualization of the cavity was not successful.



FIG. 1. The tumor mass seen on lateral surface of left thigh was the only sign or symptom complained of by the patient. The mass measured approximately 8 inches in diameter.

On August 16, 1941, the tumor was aspirated and 500 cc. of thick, smoke-colored fluid was withdrawn, thereby reducing the cyst to about one-half its size. A specimen of the aspirated material was sent to the laboratory for smear and culture and no growth was reported. However, a Wassermann examination was done on the material and reported by the laboratory as positive.

On August 22nd, the cyst was again aspirated and 800 cc. of the same type fluid obtained. The specimen was sent to the laboratory and was again reported, "no growth."

A third aspiration was done on August 30th, and 500 cc. of fluid was withdrawn. No change in the consistency of the material was noted as compared with that previously withdrawn.

On September 3rd, a genitourinary consultant advised antiluetic treatment for latent syphilis.

On September 10th, the tumor was once more aspirated and 500 cc. of fluid withdrawn. No changes were noted in the consistency of the fluid on gross inspection. As a result of consultation with members of the surgical staff, exploration of the tumor was decided upon with the possibility of finding some type of bizarre cyst. During this month of hospitalization the patient had remained free of symptoms and was ambulatory most of the time.

The tumor mass was opened on September 16th, and a large amount of smoke-colored fluid escaped from the tumor. The cystic mass was found to communicate with an opening posterior to the left hip joint and not with the joint proper. The wound was packed with iodoform gauze and sutured. It drained profusely until September 28th, at which time the sutures were removed. The lower third remained unhealed and continued to drain.

On the evening of October 15th, the patient developed a feeling of general malaise and aching of the entire body. On the morning of the 16th he had developed facial edema and temperature of 102°F. The wound was dressed and 200 cc. of light yellow fluid of a homogeneous, watery consistency escaped from the wound. On October 17th, the temperature was 103°F. and patient appeared to be definitely acutely ill. The patient's temperature, respiration, and pulse continued to mount, and his condition became critical on October 18th. The patient's course was progressive; temperature 105°F., delirious, comatose, moribund. He expired on October 19, 1941, at 10:55 A.M. despite all emergency measures employed, including continuous oxygen, blood transfusions, and cardiac stimulants.

The autopsy findings are quoted as follows:

*"External Examination.* The body is that of a well developed and fairly well nourished white male, 33 years of age. The pupils are round and equal and are neither dilated or contracted. The thyroid is not palpable. The chest is natural in contour. The abdomen is flat. The external genitalia are those of the normal male. There is a partially healed incision about 15 cm. long extending perpendicular to and over the greater trochanter of the left femur. The skin has healed on the upper half of the incision. In the lower half the edges are widely separated. Through this incision a tract may be palpated extending posterior to the femur and anterior to the sacrum. The walls of this tract are covered with dark grey exudate. There is extensive dark purplish-blue discoloration of the skin involving the face, trunk and extremities. The discoloration is most marked over the back of the shoulders. It is more marked on the left thigh than on the right. There is no recognizable subcutaneous edema.

*"Peritoneal Cavity.* The peritoneum is moist, smooth and glistening. There are numerous dense adhesions about the stomach. These are most marked about the pylorus. There are dense adhesions between the upper surface of the left and the right dome of the diaphragm. The dome of the diaphragm is at the level of the 4th rib on the right and the 4th interspace on the left.

*"Pleural Cavity.* The pleura is moist and smooth. The lungs are free in the pleural cavity, except for a few dense adhesions between the apex of the right lower lobe and the posterior chest wall.

*"Pericardial Cavity.* The pericardium is moist and smooth. There are no adhesions. The cavity contains no excess fluid.

*"Heart.* The heart is about natural in size and contour. The epicardium is smooth. The myocardium is dark brownish-red, the brown being somewhat more marked than is natural. The muscle is somewhat softer and more friable than is natural. The walls of all chambers are about natural in thickness. The endocardium is smooth and the valve cusps grossly natural. None of the rings are dilated. The cusps of the aortic valve are not separated. There is a slight thickening of yellowish discoloration of the endocardium just below the aortic cusps. The first few cm. of the aorta shows no pathological change. There is considerable longitudinal wrinkling of the intima of the descending aorta along the origin of the intercostal arteries.

*"Lungs.* The lung tissue is dark reddish-grey, heavy, and subcrepitant. There is a semi-firm nodule about 6 mm. in diameter located 1 cm. deep to the pleura in the upper lateral portion of the right lower lobe. No other nodule and no areas of consolidation are found. The hilus and tracheobronchial lymph node are not involved.

*"Liver.* The liver is about normal in size and contour. The capsule is smooth except where already described adhesions were broken. The tissue is yellowish-brown and about natural in consistency. The lobular markings are distinct but not unusually prominent. The gallbladder is grossly natural.

*"Spleen.* The spleen is moderately enlarged. Estimated weight is 150-175 gms. The capsule is smooth and thin and the borders are slightly rounded. The tissue is relatively firm. The cut surface is dark reddish-purple. The lymphoid follicles are quite prominent. Only a small amount of pulp adheres to the knife on scraping.

*"Adrenals.* The adrenals are natural in size, contour and gross appearance.

*"Kidneys.* The kidneys are about natural in size, contour and consistency. The capsule of each strips easily, leaving a pale, red, smooth surface. On section the cortico-medullary markings are distinct. The vascular markings are grossly natural. The right ureter is moderately dilated. The left is not. Neither kidney pelvis shows any pathological change.

*"GI Tract.* 2 cm. below the pyloric ring on the posterior surface of the duodenum is a

small irregular crater with a smooth fibrous base. The crater is about 1 cm. in greatest diameter. There is no evidence of acute inflammation about the crater. The remainder of the GI tract shows nothing unusual.

*"Pelvic Organs.* Show nothing unusual.

*"Head.* The scalp and calvarium are grossly normal. The dura is smooth. The fluid in the subarachnoid space is clear. The brain shows nothing unusual.

*"Sinus Tract.* The sinus tract is large enough at its nearest point to admit the index finger passing from the wound on the left side posterior to the left femur and anterior to the sacrum, and it communicates with an abscessed cavity which is located upon the anterior surface of the sacrum. The cavity extends upward posterior to the peritoneum and medial to each psoas muscle as high as the 4th lumbar vertebrae. The anterior surface of the sacrum is roughened; otherwise, the bones show no grossly recognizable pathological changes. The spinal canal was opened by chiseling through the body of the 4th lumbar vertebra. Its lining was found to be smooth, and its contained fluid clear.

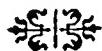
*"Anatomical Diagnosis.* 1. Tuberculous osteomyelitis of the 2d and 3d sacral vertebra with psoas abscess, left. 2. Luetic aortitis. 3. Passive congestion of lungs, marked. 4. Hydroureter, right, mild."

#### COMMENT

The small solitary nodule in the lung was found, on microscopic examination, to be tuberculous. A piece of bone taken in the region of the 2d and 3d sacral vertebrae was also found to be tubercular on microscopic examination at our laboratory here at Camp Shelby, Mississippi, and confirmed at the Army Medical Center, Washington, D. C.

A brief description of the microscopic findings of the bone slide follows:

"Sections of the sacral bone reveal extensive necrosis where the trabeculae are granular, devoid of cells and without the usual caseous markings. The adjacent marrow spaces are filled with shadowy and vaguely cellular necrotic material. The marrow spaces which are outside of the necrotic lesions are filled with connective tissue, lymphocytes, remnants of bone marrow and a granulation tissue which is infiltrated with lymphocytes and monocytes. In some places these cells form small tubercles which often have caseous necrotic cores. There are also occasional foreign body giant cells of the Langhans type."



# PRIMARY SARCOMA OF THE URETER

## CASE REPORT AND REVIEW OF THE LITERATURE

LEE RADEMAKER, M.D.

Diplomate of American Board of Surgery; Surgeon and Director of Pathology, Peninsula General Hospital  
SALISBURY, MARYLAND

**R**EPORTS of primary sarcomas of the ureter are so rare that review of the literature is comparatively easy. The first case was reported by Ribbert in 1886—a spindle cell sarcoma in a girl four years of age. It arose primarily from the renal pelvis and contained numerous layers of striated muscular fibers.

Lichthin and Willin<sup>ly</sup> have described a case of "alveolar" sarcoma of the ureter; Target and Meller (1920) have described a case of round cell sarcoma. Neumirth (1928) described a spindle cell sarcoma about the size of a walnut found in the lower third of the ureter in a male aged fifty-one.

Stewart and Kummel, quoted by D'Aunnoy and Zoeller (1930) agreed that only five cases of sarcoma existed in the literature at the time of their review.

In a more recent review of the problem of malignancy of the upper urinary tract by George Gilbert Smith (1935) two cases of fibrosarcoma and one case of leiomyosarcoma are reported by Smith as personal cases but he stated that it was impossible to determine whether the primary tumor was in the kidney or ureter. Sarcoma primary in the kidney is not as rare as the above scarcity would indicate, and one would consider from Smith's remarks that these cases were primarily renal sarcomas.

Search of the literature since this report has failed to disclose other cases of primary ureteral sarcoma, so that we believe that the present case represents the sixth known report of primary sarcoma of the ureter.

Location of the tumor in the other cases has varied; two reported near the kidney, two about two inches from the bladder and not stated in one. Symptoms have

varied from hematuria, to pain and discovery of mass; and the size of the tumor has varied from that of a walnut to that of a grapefruit. Age has varied from four to fifty-three years.

### CASE REPORT

Mrs. L. S., aged fifty-nine, a white woman, was admitted to my service at the Peninsula General Hospital of Salisbury, Maryland, on December 9, 1941. She was referred by Dr. John Yeaman. Her chief complaint was that of a heavy dull ache in the upper, left side of the abdomen, gas, and a lump in her side.

She had been well until July, 1941, when this aching sensation first appeared, accompanied by a sense of pressure and much belching of gas. The pain was at first intermittent and became progressively worse. The month before admission she first noticed the mass which felt like a ball. This had progressively increased in size and had become very tender, feeling to her to be the size of a grapefruit. She felt that the mass throbbed constantly, a sensation which was temporarily relieved after a bowel movement.

There had been no hematuria, frequency, or nocturia and no pain in her back. She had been constipated most of her life, and this had increased in the past few months. There was no history of passing blood by bowel. There was no history of indigestion and ingestion of food had no effect upon the pain.

The past medical history was negative: no serious illnesses, accidents or operations. The menopause occurred at age fifty-four, with no bleeding or discharge since. She had had eight children, three of whom were dead; one of tuberculosis and diabetes.

Her father and mother died at the age of seventy-three of apoplexy and Bright's disease, respectively; five sisters and one brother were living and well; one brother died of heart disease and one sister died of hypertension.

Physical examination showed a pale, elderly, white female of average nutrition. Blood pressure 174/102; temperature 98; pulse 84;

Fragility test showed hemolysis to begin at 0.46 per cent and to complete at 0.34 per cent. Repeated urinalyses showed no red blood cells;



FIG. 1. Intravenous pyelogram. The mass is shown with moderate degree of hydronephrosis. The ureter is shown a short distance within the mass.

respiration 20. The examination was negative except for complete adentia and the abdominal findings. The abdomen was dome shaped with normal liver dullness. There was considerable distention with gas. A large, smooth, clearly defined mass was palpable in the upper, left quadrant. The mass was not attached to the anterior abdominal wall and did not seem fixed in that it could be moved about 1 inch in all directions. It was very tender, especially at the upper pole. It seemed to be about the size of a large grapefruit and occupied all the left, upper quadrant. It could not be palpated posteriorly and there was no posterior tenderness. Pressure on the mass caused definite pulsation to occur, transmitted probably from the aorta. The remainder of the physical examination was negative.

Laboratory studies showed the following: hemoglobin 80 per cent; red blood cells, 4,070,000; white blood cells 4,350; neutrophiles 72 per cent; lymphocytes 28 per cent; blood urea 54 mg., urea nitrogen 25 mg., blood platelets 345,750. Prothrombin time 27 seconds.



FIG. 2. Intravenous pyelogram which shows an abrupt ending of the ureter within the mass.

two to six white cells and showed no abnormality either grossly or microscopically.

An intravenous pyelogram by Dr. Jack K. Williams showed a moderate hydronephrosis on the left side. On the right side there was a moderate ptosis of the kidney with some kinking of the ureter. The left ureter showed an abrupt ending within the tumor mass on some pictures. (Figs. 1 and 2.)

The barium enema was negative. All abdominal films showed the outline of a rounded mass in the upper left quadrant. (Fig. 3.)

After these findings and study, operation was planned as an exploratory laparotomy. Five hundred cc. of blood was drawn from a suitable donor before the operation began.

Operation was performed on December 12, 1941, under nitrous oxide, oxygen and ether using the closed method. A left, rectus incision was made in the upper part of the abdomen. There was a large, smooth mass  $12\frac{1}{2}$  cm. in diameter, spherical in shape, located beneath the left kidney and retroperitoneal in position. It was well supplied with blood, a large vein being attached to the left renal vein directly.

It was well encapsulated, freely movable and no metastasis was apparent. The left ureter went directly through the center of the growth.



FIG. 3. Barium enema showing the transverse colon in front of the mass. The descending colon is pushed far laterally.

The posterior parietal peritoneum was loosely attached to the growth capsule. Some fibrous tissue also loosely attached the growth to the lower pole of the right kidney, but this was only loose areolar tissue. The only firm attachment, therefore, was to the ureter which coursed through it from an area about 1 inch beneath the kidney pelvis to about three inches from the bladder.

The intestines were packed away from the operative site. A vertical incision was made in the posterior peritoneum, two inches to the left of the midline. The growth was then carefully removed until its only attachment was to the large vein to the renal vein, and to the ureter. At this time the vein tore, although great care had been exerted to prevent just this accident. A large amount of hemorrhage occurred in a few seconds before the renal pedicle could be clamped. The kidney was then removed and the ureter dissected to its entrance to the bladder and also removed. Blood trans-

fusion was started an instant after hemorrhage occurred, and a second transfusion was given immediately after completion of the first. The kidney pedicle was ligated with four chromic catgut ligatures, the ureteral stump ligated and carbolized, and the posterior peritoneum closed with catgut. Two Mikulicz drains were placed to this incision and the anterior wall incision closed in routine manner, using stainless steel wire to close the anterior fascia.

The blood pressure dropped to zero and the pulse became imperceptible for a period of three minutes after the hemorrhage, but rose rapidly as a result of the transfusion and the patient left the operating room in fairly good condition.

Shock treatment was carried out and convalescence was entirely uneventful. Drains were removed on the third day. A 500 cc. transfusion was given in divided doses on the second and third postoperative days. On December 12, 1941, her blood count was as follows: hemoglobin, 82 per cent; red blood cells 4,240,000; white blood cells 7,800 with normal differential. She was discharged on the fourteenth postoperative day in good condition.

Pathologically, the specimen consisted of a globular solid tumor measuring  $12\frac{1}{2}$  cm. in diameter, which had a firm fibrous consistency and on section showed a uniform structure. The growth was well encapsulated and no break in the capsule was present, except for ureter which coursed directly through the mass and to which the mass was attached.

Microscopically, it was diagnosed leiomyosarcoma. (Figs. 4 and 5.)

Sections were submitted to Dr. Howard J. Maldeis, of Baltimore, Maryland, and Dr. Albert Bothe, of Philadelphia, Pennsylvania, and this diagnosis was corroborated by both pathologists. Dr. Maldeis added that many parts of the sections showed myxomatous changes.

Routine follow-up examination on March 24, 1942, showed no symptoms. The patient had mild coryza for two days. She had gained five pounds in weight since the operation. Her present weight is 129. The incision was well healed and there was no evidence of recurrence and no urinary symptoms.

Follow-up examination on February 6, 1943 revealed that the patient had gained steadily in weight, her weight at that time being  $137\frac{1}{2}$  pounds. The incision remained well healed.

There were no symptoms of recurrence or metastasis. Palpation and percussion revealed no tenderness, masses or liver enlargement

procedure. It is yet too early to discuss the final end result, although in comparison to the average sarcoma, fourteen months



FIG. 4. Microphotograph under low power.

and there were no urinary symptoms. Blood pressure was 150/80. X-ray of chest was entirely negative for metastasis.

#### CONCLUSION

We have herewith reported a case of leiomyosarcoma of the ureter which represents to the best of our knowledge the sixth reported case of primary sarcoma of the ureter. The marked features of the growth were its relatively few symptoms, its large size without obvious metastasis, its good encapsulation and its low index of malignancy. The difficulties in diagnosis are obvious because of the negative laboratory and x-ray findings. Ready and easy removal complicated by violent hemorrhage for which the surgeon had completely prepared and smooth postoperative convalescence characterized the operative



FIG. 5. Microphotograph (high) showing myxomatous degeneration and smooth muscle strands.

without detectable recurrence or metastasis indicate a fairly hopeful prognosis.

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THE commonest cause of delayed union in closed fractures is inadequate splinting. Fractures in certain locations as the neck of the femur and the wrist joint unite more slowly than the average. Most cases respond to further immobilization and frequent applications of heat.

# TRAUMATIC ARTERIOVENOUS FISTULA OF THE BRACHIAL ARTERY AND VEIN\*

JOHN HERRLIN, JR., M.D. AND WALTER L. MERSHEIMER, M.D.  
NEW YORK, NEW YORK

TRAUMATIC arteriovenous fistulas occur less frequently in the great vessels of the neck and upper extremity than in the vessels of the lower extremity.<sup>1-7</sup> Common locations for arteriovenous fistulas are between the common carotid and jugular vein, the interval carotid artery and cavernous sinus, the femoral artery and vein, and between the axillary artery and vein.<sup>8</sup> Mason<sup>9</sup> collected fifty-nine cases involving the subclavian, and Mason and Pool<sup>10</sup> reported in a series of fourteen cases two involving the subclavian and two the brachial arteries. Matas<sup>11</sup> recorded two cases of arteriovenous fistula of the brachial artery and vein. Andrus<sup>12</sup> has recorded traumatic arteriovenous fistula of the palm and quotes Lyle as stating that there are sixty-six such cases reported.

The pathological and pathological physiological effects of an arteriovenous fistula have been investigated and reviewed by others.<sup>13-16</sup> Dilatation and hypertrophy of the heart and later cardiac decompensation with peripheral edema and ascites may occur. There is also an increased blood pressure and tachycardia, increased blood volume, diminished peripheral resistance at the site of the fistula, and abnormal oxygenation of blood due to admixture of venous and arterial blood at the site of the fistula. Brenham's tachycardiac sign is well known. There is a usually good collateral circulation developed when arteriovenous fistula is present. Venous pressure readings at the site of the fistula and, particularly, comparison of the well and affected side and arteriography in selected cases may aid in definitely establishing the diagnosis.

## CASE REPORT

J. C., a male, age six, was admitted to Metropolitan Hospital January 2, 1941 because of a peculiar buzzing sensation in the child's right arm. This began approximately eighteen months before. At that time, the patient fell on a broken milk bottle and sustained a laceration of the right arm  $1\frac{1}{2}$  cm. above the medial epicondyle of the right humerus 0.6 cm. long. A local physician closed the laceration with two skin clips without any further investigation of the injury. The parent stated at the time of the injury that the child lost a large amount of blood and looked very pale and weak. The hemorrhage was only controlled when a neighbor applied a tourniquet. The bleeding was also described as bright red color and spurting.

The skin clips were removed on the fifth day following the injury; the wound apparently healed by primary union. The patient was asymptomatic until approximately six months later when the child's mother noticed a peculiar buzzing sensation in the region of the injury. The parents believed this condition would gradually disappear and no physician was consulted at the time. The child during this period of time exhibited no unusual symptoms, playing with his friends and showing no signs of cardiac embarrassment. No local signs were apparent in the right upper extremity, excepting the buzzing sensation.

The patient had an occasional cold and sore throat. He had been unable to gain weight, but the remainder of systems were noncontributory.

Examination of the head revealed a small 2 cm. laceration of the right occipital region which apparently was healing well. Extraocular movements of the eyes were normal; pupils were round, central, and equal; they reacted promptly to light and accommodation. There was no obstruction or discharge in the ears and the tympanic membranes were normal.

\* From the Department of Surgery, New York Medical College, Flower and Fifth Avenue Hospitals, and Metropolitan Hospital, Dr. Louis Rene Kaufman, Director.

A crusting was noted in the anterior nares with slight serous discharge. There were numerous small areas of caries in the teeth. The pharynx was slightly injected; there was no postnasal discharge. The tonsils were hypertrophic and cryptic. The trachea was in the midline; there was anterior cervical adenopathy bilaterally. The chest was symmetrical and expansion equal; there was no dilation of the superficial veins. The lungs were resonant, tactile, and vocal fremitus was normal; breathing was vesicular—inspiratory “cogwheel”—no râles were noted.

The heart showed a visible apex pulsation in the fifth interspace 2 cm. to the left of the midclavicular line, and the maximum apex beat was palpated at the same point. Heart percusses were slightly enlarged, rhythm was regular, the rate being 100. Sounds were forcible and of good quality. There was a faint systolic murmur heard at the apex. Blood pressure: right arm 100/0, left arm 98/52.

The abdomen was symmetrical and moved readily with respiration. There were no scars or visible masses and no dilation of superficial veins. There was no spasticity and no tender points to palpation. The liver, spleen, and kidneys were not palpable. There was no evidence of hernia. There were bilateral small, freely movable glands palpable. The genitalia revealed constriction of the prepuce. The scrotum and testicles were normal. The rectum was not examined. The lower extremities were normal; reflexes were physiological.

The upper-left extremity was apparently normal, although it did show readily visible superficial veins on the anterior surface of the forearm and at the cubital fossa.

The upper-right extremity was apparently normal in size and shape. Dilated veins in the forearm and arm were noted on the anterior and medial surfaces. On close inspection, there was slight pulsation visible in the superficial veins which was synchronous with the apex beat of the heart. There was also noted a small white scar 0.6 cm. in length on the medial surface of the arm 1.5 cm. above the crease of the elbow. There was no clubbing of fingers, no visible capillary pulsations of finger tips, no cyanosis with arms level, depressed, or raised. There was a thrill palpable from a point 2 cm. below the elbow crease extending along the anterior and medial aspects of the arm and was palpable throughout the arm, in the axilla,

and also in the supraclavicular region. The maximum area was 5 cm. long extending from the scar previously described. Superficial veins in this area when palpated pulsated synchronously with the apex beat of the heart. By means of auscultation a loud roaring bruit was heard synchronous with the apex beat of the heart from a distance of 5 cm. below the elbow crease along the anterior and medial surfaces of forearm and arm. This was also heard in the axillary and supraclavicular regions. The maximum point of intensity was about 3 cm. above the scar previously described.

#### COMPARATIVE MEASUREMENTS OF UPPER EXTREMITIES

Circumference	Right, Cm.	Left, Cm.
Above biceps.....	16.2	15.6
Midbiceps.....	16.5	16.0
Below biceps.....	16.0	15.4
Elbow.....	16.0	16.0
Midforearm.....	15.5	15.0
Wrist.....	12.0	11.8

Length	Right, Cm.	Left, Cm.
Tip of acromion to tip of middle finger.....	52.5	52.5
Tip of acromion to tip of olecranon.....	19.5	19.5

When arms were level, the right radial pulse felt slightly weaker than the left, and there was a suggestion of Corrigan “Water Hammer pulsation.” When the arms were raised, pulsation were about equal, and the “Water Hammer” sensation was increased. When the “fistula” was obliterated by direct pressure, pulsations were about equal.

When arms were level, pulse was regular, and the rate was 100 per minute. When the right arm was raised, the pulse rate fell slightly—rate 92 per minute. When the “fistula” was completely obliterated by direct pressure or the application of a cuff, the radial pulse rate came 80 to 82 per minute.

Blood pressure was difficult to determine accurately in the right arm but the average of many readings was 100/0. The left arm was 98/52. When the right arm was raised and pressure taken on the left, there was a slight

rise in the diastolic, but no appreciable change was noted in the systolic value 98/60. When the "fistula" was obliterated by direct pressure or the application of a cuff, there was a marked rise in diastolic but only slight in the systolic 102/80. Blood pressures of both lower extremities were recorded as equal 108/62.

COMPARATIVE SKIN TEMPERATURES: ROOM TEMPERATURE: 23.5°C.

	Right	Left
Wrist.....	34°C.	35°C.
Forearm.....	34°C.	35°C.
Elbow.....	35°C.	36°C.
Biceps.....	35°C.	36°C.

Temperatures were taken on volar surfaces. Also numerous points were tested in the region of the scar, and the dilated superficial veins, but no local variations were noted.

COMPARATIVE OSCILLOMETRIC READINGS

Pressure	Right		Left	
	Arm	Forarm	Arm	Forarm
110	1.0	0.5	0.5	0.5
100	3.0	1.0	0.5	1.0
90	4.0	1.5	1.0	1.0
80	7.0	2	1.5	1.0
70	10.0	4	2.0	1.5
60	11.0	4	3.0	2.0
50	12.0	4	2.0	2.0
40	8.0	3	1.5	1.5
30	6.0	2.5	1.0	1.0
20	4.0	2	1.0	1.0

Intradermal wheals of histamine were raised with 0.1 cc. of 1-10,000 on both upper extremities on the volar surfaces at the following levels; wrist, midforearm, elbow and midbiceps. There was an immediate response at all points with the wheals measuring 1.0 cm. in diameter and the surrounding "flares" measuring 4.0 to 5.0 cm. in diameter.

Direct venous pressure readings were taken from veins of right forearm at the elbow in the region of the scar. Attempts were made to select veins that pulsated. Pressures were not excessively high; the highest recorded was 15 to 16 cm. of water.

Circulation time was tested by injecting 0.5 cc. of alpha lobeline into a vein of the right forearm in the region of the scar. An attempt was made to select a vein that pulsated. From the time of injection till the patient coughed was about 6 seconds.

#### LABORATORY DATA

Urinalysis:	1/2/41	1/3/41
Color.....	Yellow	Yellow
Appearance.....	Cloudy	Cloudy
Specific gravity.....	1.018	1.018
Albumin.....	Negative	Negative
Glucose.....	Negative	Negative
White blood cells.....	Few	Few
Epithelia cells.....	Few	Some
Hemogram:		
Hemoglobin.....	90%	
Erythrocytes.....	4,500,000	
Leucocytes.....	7,050	
Mature polymorphonuclear leucocytes.....	46	
Immature polymorphonuclear leucocytes....	4	
Lymphocytes.....	49	
Monocytes.....	2	
Eosinophiles.....	2	
Basophiles.....	,	
Blood Chemistry:		
Sugar.....	75	
Nonprotein nitrogen.....	29	
Creatinine.....	1.3	
Carbon dioxide combining power	48	Volumes Per Cent
Chlorides plasma.....	530	
Blood Sedimentation Rate.....	15 Minutes-o 1 Hour-4 mm.	

Blood from the right arm was taken from pulsating vein in neighborhood of the fistula. Blood from the left arm was taken from vein in cubital fossa. Oxygen determinations were as follows:

#### Right Arm: Content of Oxygen:

15.51

15.44

#### Right Arm: Saturation:

88.7%

#### Left Arm: Content of Oxygen:

13.54

13.37

#### Left Arm: Saturation:

77.0%

#### Capacity of Oxygen:

17.61

17.60

X-ray examination of the chest and upper extremities revealed the following: The lung fields were equal in illumination. The hilar and bronchovesicular markings were exaggerated. The costophrenic sinuses were clear. The diaphragmatic domes were smooth and the cardiovascular shadow was normal. The radio-

graphic examination of both upper extremities showed no variation from the normal in the osteology or soft tissue structure.

fistula of the right brachial artery and vein. The operative diagnosis was the same.

The skin was prepared with tincture of



FIG. 1. Dissection of U-shaped aneurysm.

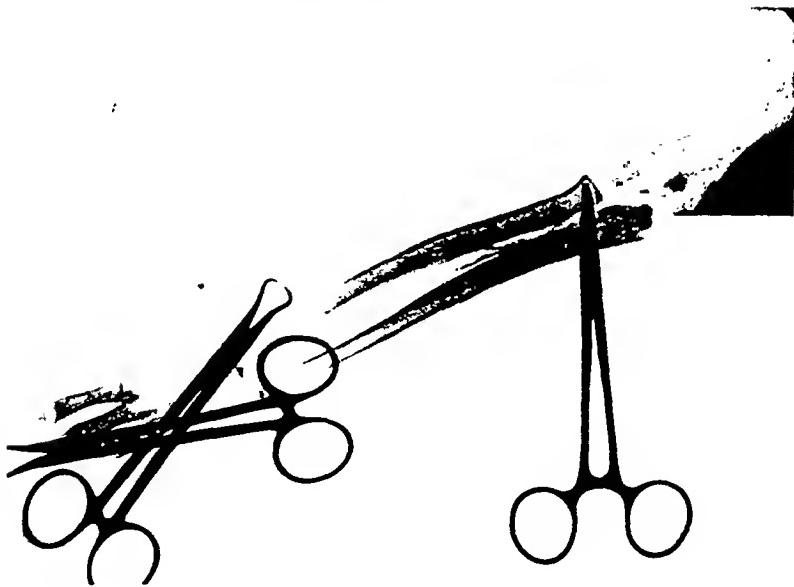


FIG. 2. Visualization with hippuran.

**REPORT OF ELECTROCARDIOGRAM JANUARY 3, 1941**

Auricular rate..... 110 per min.  
Ventricular rate..... 110 per min.  
Interpretation: Sinus tachycardia  
P-R Interval..... .14 Sec.  
Q. R. S. Interval..... .06 Sec.

**REPORT OF ELECTROCARDIOGRAM JANUARY 10, 1941**

Interpretation: Sinus tachycardia

Operation was performed on January 4, 1941. The preoperative diagnosis was arteriovenous

methiolate. An incision was made along the medial border of the biceps proximal to the original penetrating wound, down through the deep fascia isolating the brachial artery and vein. The incision was continued distal to the original wound, again isolating the brachial artery and vein. Numerous small veins connecting with the brachial vein were isolated and in some instances ligated in order to

visualize the field better. The median nerve appeared in the field and was carefully protected. The arteriovenous fistula appeared in an H-shape configuration (Fig. 1), showing a definite connection between the brachial artery and vein. Venous pressures were taken and recorded as follows: 28 cm. of water in the brachial vein. Proximal and distal tourniquets were placed on the arm and forearm and 15 cc. of hippuran was injected intravenously into the brachial vein, the distal tourniquet released, and roentgenograms taken. (Fig. 2.) Proximal and distal ligations in relation to the aneurysmal sac were done on the brachial vein, and the aneurysmal sac was ligated close to the brachial artery with two ligatures of black silk. Silk technic was used throughout. The wound was closed with interrupted black silk sutures.

Postoperatively, the patient was in good condition. Pulse 130; blood pressure 102/60, left arm. During and immediately following operation, he was given 500 cc. of 5 per cent dextrose in physiological saline. In the afternoon of the same day the pulse was 120, regular and of good quality; there was no staining of the dressing. The child reacted from anesthesia and took small sips of fluids by mouth, was quiet and apparently comfortable. On January 6th, there was very slight edema of the right hand, pulse 84; temperature 99.4°F. On January 8th, the dressing was removed and there was slight edema of the arm noted. The wound was healing well without discharge. Every second black silk suture was removed. There was slight separation of skin edges at the lower end of wound. This was coapted with two flamed "dumb-bell" adhesives and a dry gauze dressing. Pulse rate was 86 full and regular; blood pressure 92/64—left arm. Two days later the dressing was removed. The incision was clean and healing well. All remaining black silk sutures were removed and two additional "dumbbell" adhesives placed. The patient completely recovered and was discharged to a private physician.

Radiographic examination made at the time of operation of the right-upper extremity, after visualization of the vessels with hippuran, showed the brachial artery and several of its branches in the region of the lower-most portion of the humerus and the radial and ulnar arteries with their branches. A distended portion of vein (brachial) overlying the lower end of the humerus was also noted.

The gross pathological description was as follows: Specimen consisted of a small piece of tissue, hard in consistency, and the appearance of and said to be a vein. Microscopically, the tissue was vein with marked proliferation of the intima with partly organized clot. Diagnosis: Chronic endophlebitis.

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# MULTIPLE PYOGENIC LIVER ABSCESSES\*

## REPORT OF A CASE DUE TO BACILLUS PYOCYANEUS WITH RECOVERY

HENRY G. WILLIAMS, M.D.

Chief of Staff, Good Samaritan Hospital

AND JAMES M. OVENS, M.D.

Consulting Surgeon, United States Indian Sanitarium

PHOENIX, ARIZONA

**B**Y multiple pyogenic liver abscesses we mean more than one simultaneous inflammatory process in the liver caused by a bacterium and continuing to suppuration. Parasitic abscesses are not included. Abscesses due to the gas forming organism do not form suppurative lesions. They are not a medical rarity, but are seen rather frequently in surgical practice and are more common than single pyogenic abscesses.<sup>1</sup> They are usually a sign of neglect or of too late an institution of adequate treatment.

### ETIOLOGY AND PATHOGENESIS

Multiple liver abscesses are always the result of spread of infection from a primary focus elsewhere in the body and are transported to the liver via the

#### i. Portal Vein

- A. Appendix
- B. Rectum
- C. Colon

#### ii. Bile Ducts

- A. Gallbladder and ducts
- B. Small intestine (typhoid)

#### iii. Systemic Circulation

- A. Spread from suppuration elsewhere via hepatic artery

#### iv. Trauma

- A. Penetrating injury with introduction of infection
- B. Contusion and degeneration of liver substance and infection

#### v. Lymphatic Spread

- A. Gallbladder
- B. Intestine
- C. Umbilicus

#### vi. Umbilical Vein

- A. Umbilical infection in newborn

#### vii. Spread of Contiguity

- A. Perforation of stomach, duodenum, and colon

#### B. Perforation of gallbladder

Approximately 50 per cent of the cases are a result of acute appendicitis<sup>3</sup> and pylephlebitis. Infections and ulcerations of the colon and rectum are rarer causes of abscesses of the liver. Infection of the extra hepatic biliary system behind an obstruction in the common duct is the second<sup>3</sup> most common cause of multiple liver abscesses. Ascension through the common and hepatic ducts must not be overlooked in cases of abscesses due to the typhoid bacillus although typhoidal pyemia is probably the more common cause. Suppurative processes reaching the liver via the hepatic artery may arise from a carbuncle, osteomyelitis, bronchiectasis, heart or other focus of infection giving rise to a septicemia. Traumatic origin of liver abscess is not as common a cause as one would believe with the liver being one of the most commonly injured of all intra-abdominal organs. However, traumatic multiple abscesses probably rate third in order of frequency. The spread of infection to the liver from the gallbladder,<sup>9</sup> intestines or umbilicus is not rare. Infection of the umbilicus of the newborn with resultant liver abscesses is becoming a medical rarity and when found now is usually the result of the midwife or neglected baby and not an occurrence in a well regulated maternity hospital or ward. A perforation of the gallbladder, stomach or intestine with its contiguous location does not result in intrahepatic abscess formation unless it is a case of a

\* From the Lois Grunow Memorial Clinic, Section on Surgery, Phoenix, Arizona.

missed diagnosis, or a silent condition, slow perforation, walling off and gradual spread by spilling of the contaminant.

The bacteriological cause of abscess may be many. *Bacillus coli* is the leading agent.<sup>2</sup> Hemolytic, non-hemolytic and viridans streptococci, *albus*, *aureus* and hemolytic staphylococci, pneumococci, *Bacillus faecalis alcaligenes*, *Bacilles subtilis*, diphtheroids, *Bacillus protens*, spirochetes,<sup>6</sup> Friedlander bacillus,<sup>12</sup> *Bacillus pyocaneus* have all been found as causative organisms.

#### PATHOLOGY

The distribution of the pathological processes in the liver depends upon whether or not the infection is brought to the liver by means of the hepatic artery, portal vein or bile duct ascension. The abscesses are more pronounced around the bile ducts in cholangitis. The liver is grossly enlarged. The surface nodules or softened areas may be palpated. The edges are palpable and the color dark green or blue or tinged with a jaundic hue. On cut section, the areas of necrosis may be seen like bird shot and large varying in size, softened, filled with pus, the cavities containing ragged edges and perhaps bile stained pus, especially in the cholangenic abscesses.

The microscopic picture is typically one of necrosis with polymorphonuclear infiltration with pyogenic membrane formation being attempted, the intervening hepatic cells being the seat of cloudy swelling or toxic degeneration. The bile ducts may be dilated if obstructed and filled with bile stained pus.

#### SIGNS AND SYMPTOMS

The signs and symptoms may be briefly tabulated as:

Signs	Symptoms
Tenderness.....	Fever
Rigidity.....	Chills
Enlarged liver.....	Nausea
Palpable mass.....	Vomiting
Ascites.....	Pain
X-ray evidence.....	Dyspnea
Toxicity.....	Lassitude
Jaundice.....	Sweating

#### DIAGNOSIS

The presence of multiple liver abscesses may well be suspected in a patient who has appendicitis, or who has had an appendectomy and develops chills, fever and tenderness over the liver region, especially if the organ becomes palpable and the white count becomes elevated. Charcot's triad of fever, chills and jaundice in hepatobiliary disease points to cholangitis which if not relieved will go on to abscess formation in most cases. Nausea and vomiting may be suspected in practically all cases. Tenderness over the liver, muscle guarding or rigidity, palpable liver and right scapular pain are all localizing aids. With acute suppurative processes within the liver parenchyma a high leucocytosis is to be expected and should exceed 25,000 white blood count per cubic millimeter of blood, with a strong shift to the left, unless the patient is in a very poor condition. Dyspnea, extreme lassitude, and profuse sweating are associated findings. These patients are extremely sick, perhaps too weak to talk out loud. Ascites may develop in severe cases.

Thorium dioxide as an aid in diagnosis of these cases is not as important as it is in the diagnosis of solitary liver abscess. Three to four days are necessary for the best results<sup>10</sup> since the drug must be given intravenously daily for three days and is then phagocytized. Any ill effects of the radio-active drugs develop slowly and would appear later.

X-ray elevation of the right side of the diaphragm with or without basilar atelectasis or effusion is suggestive of subdiaphragmatic or intrahepatic mischief. The absence of primary lung disturbance and the restricted movements of the diaphragm aid in roentgen diagnosis. Deep abscesses, abscesses in the undersurface of the liver or the left lobe are less apt to produce these findings.

#### TREATMENT

With a condition which is so often fatal, and which is shown statistically to have a

mortality rate of more than 95 per cent, treatment is a problem of prophylactic practice primarily. Perhaps an appendix may be removed that is not suppurative, perhaps a normal appendix may be removed; but rarely does death follow these uncomplicated procedures. The antiquated belief that surgery is for the gallbladders with stones only is to be abandoned. The constantly falling operative mortality, the newer anesthetics (for many people dread an operation because of "coming out of ether") will aid in allaying the patient's fear of operation. Keener diagnosis and more thought and thoroughness shown by physician and surgeon alike will aid in more sharp diagnosis and earlier operations for conditions causing these complications.

In active treatment, cardinal principles may be stated which apply in such a pathological state anywhere. Besides these there are special points of interest that should be mentioned, namely: (1) Proper preparation of patient; (2) treat primary site; (3) drain pus, if possible; (4) modern chemotherapy where possible; (5) Special means of treatment: (a) negative bladder pressure, (b) negative intraductal pressure.

*Proper Preparation and Nourishment.* In toxic liver conditions one of the most important functions to fail rapidly is glycogenesis<sup>3</sup> and hence the intravenous administration of glucose solution is of utmost importance, 100 to 400 Gm. being given per twenty-four hours. Mineral and fluid balance must be maintained by means of solutions of Hartmanns, Ringers, lactate, or saline. With the liver function decreased the prothrombin time is frequently lengthened and vitamin K is necessary, especially if surgery is indicated. This may be given with bile salts if given orally, or given by hypodermic injection. Transfusions may be necessary if the patient presents a low red count, hemoglobin, or extreme toxicity.

*Treatment of the Primary Site of the Infection.* We have purposely not said the removal of the primary site for in most cases such prolonged and bothersome

surgery is contraindicated. An appendiceal abscess is better drained and the appendix left in place than to disturb any pyogenic membrane or omental wall that may be forming. To remove a diseased gallbladder full of stones, the seat of an empyema, or other inflammation may precede the signing of the death certificate. The removal of a large common duct stone which necessitates any length of time is better not done. Far better is it merely to drain the gallbladder with a tube left in the cystic duct, or merely to open the common duct, remove what stones present conveniently and place a T tube in position. When a patient can not live through these procedures, what chance has he with more insults?

A perforation in an adjoining viscus is naturally best closed if possible. Drainage of the abdomen is practically always indicated. Carbuncles are serious conditions and when a patient with a carbuncle develops multiple liver abscesses it is a sign of bacteremia and a fatal outcome can be predicted. However, cruciate incisions with copious glycerine packs or negative pressure cupping, we believe to be of more value than x-ray alone; a combination of these procedures with radiotherapy is probably the best. The wisdom of the use of x-rays and sulfa compounds together is still a debated subject.

*Drainage of Multiple Liver Abscesses.* This is feasible in practically only one instance, that is, when the suppurative processes result from cholangitis. Here the ducts can be drained and, indirectly, also the abscesses higher up, by means of cystic or common duct drainage with or without negative pressure.<sup>17</sup> Drainage of multiple abscesses originating in any other manner is inadequate. Negative intrabladder pressure will be discussed later. Surgical attack of these lesions is not practical and merely adds injury and insult to the already present condition.

*Modern Chemotherapy.* This together with the sulfa drugs may aid in the treatment of these conditions. Sulfanilamide

would be the drug of choice in streptococcal lesions. The cure of liver abscesses with sulfanilamide has been reported.<sup>15</sup> However, it appears that there are many loopholes in these reports, one case being diagnosed clinically and the other showing negative cultures. It is interesting to note that the sulfanilamide concentration in the bile reached 2.5 mg. per cent. In one case of *Bacillus pyocyaneus* liver abscesses sulfathiazole was used but no bile concentrations were determined. We believe that for routine use sulfathiazole or sulfadiazene is the drug of choice. In Friedlander's or pneumococcal infections sulfapyridine is probably the best agent.

We have a powerful weapon in these drugs, but like any other weapon, it must be used sufficiently to be of any aid defensively. These drugs should be used in large enough quantities to maintain adequate blood concentrations. Since stone formation takes place in the acid urine with acetyl formation, adequate alkalization is necessary. In many cases with excessive nausea or vomiting the soluble forms should be given intravenously. The rectal route of administration has nothing to recommend its use, unless no other method is possible.

*Special Means of Treatment.* Hendon<sup>3</sup> has described a method of producing negative pressure in the renal apparatus by producing a bladder suction. This, he states, caused an increased percentage of urinary output in relation to the fluid intake. We have never used this method and cannot speak with any authority about it.

The production of a negative pressure within the bile duct system is a method that is most commendable. Every surgeon knows the value of liver decompression in severe cases of stone with jaundice. The introduction of a cystic or common duct tube and the drainage of such with a negative pressure equal to that of a column of bile from the ducts to the bottle on the floor is one of the most important phases in

liver decompression and especially cholangiogenic abscess drainage.

Dr. W. G. Benjamin<sup>17</sup> recommends the gradual decompression of the liver to prevent the parenchymal damage and hemorrhage associated with the sudden and total release of pressure from within the ducts. He fastens his tube in securely and then at intervals allows the bile to flow off and thus gradually reduces the intrahepatic positive pressure to a negative one. We have seen many cases of cholelithiasis with white bile due to extreme liver damage drain for several days, and then have the liver cells return sufficiently to secrete well pigmented bile and go ahead to complete recovery.

#### PROGNOSIS

The mortality is high, being quoted by Ochsner<sup>7</sup> as 95 per cent in a series of twenty cases of multiple liver abscesses. In solitary abscesses, however, the mortality was 37.5 per cent in a series of twenty-four cases. Various other authors<sup>1</sup> have quoted the mortality rate at from 59 to 100 per cent in multiple liver abscesses, most statistics being over 95 per cent. The condition is met with as a complication of some other condition as will be noted, and when further complicated by spread into the thorax, pericardium, peritoneum or to other viscera, the prognosis is even more grave, recovery being extremely rare.

#### COMPLICATIONS

Multiple pyogenic abscesses of the liver are never primary, but are complications of a pre-existing condition and when further complicated a fatal outlook can be forecast. Subdiaphragmatic abscess, empyema, lung abscess, hydrothorax, pulmonary embolism, peritonitis, pericarditis, endocarditis, colon and stomach fistulas, brain abscess and amyloid disease,<sup>2</sup> all go to make the problem more widespread and fatal. All result either from direct or indirect spread of the infection except amyloid disease.

## 'CASE REPORT

A search of the literature failed to reveal a proved case of multiple liver abscesses due to *Bacillus pyocyanus* with recovery. A brief summary of such a case follows:

Mr. J. R., age sixty-five, was referred by Dr. H. J. McKeown, of the Medical Department. He was admitted to the hospital on November 14, 1941. There was a record of a previous hospital admission on February 22, 1940, for prostatic hypertrophy with mild uremia.

His chief complaints were abdominal pain, chills, and nausea for two weeks. He had had indigestion and colicky pains in the right upper quadrant for three years. Two weeks before admission he developed sharp colic and pain in the right upper quadrant accompanied by fever, chills, vomiting and sweating. This attack passed but he had numerous attacks essentially the same since then. He had clay colored stools intermittently, and developed a progressive jaundice since the first attack. He had gone down hill rapidly during the few days before admission.

He had undergone no surgery except cystoscopic work on February 22, 1940. A horse fell on the patient five years previously breaking his right arm and left leg. He never had any contagious or infectious disease.

Physical examination revealed the patient to be a thin, well developed man of sixty-five, who was jaundiced and appeared very weak and in distress. He talked with some effort. His head was normal except for a sebaceous cyst beneath the right eyebrow. The eyes were normal except for jaundiced sclerae and arcus senilis. Examination of the nose, throat, lungs and cardiovascular system showed nothing abnormal. His blood pressure was 110/65. The abdomen was puffy in appearance and markedly tender on the right side, chiefly just below the costal margin. There was splinting of the muscles on the right side. The liver, spleen and gallbladder were not palpable. The extremities showed nothing abnormal and the skin was moderately jaundiced. The axillary and inguinal glands were palpable but not tender. Rectal examination revealed a normal prostate.

Urinalysis showed the presence of bile. Bleeding time was four minutes, clotting time one minute, and prothrombin time twenty seconds (fifteen seconds equals normal). Hemoglobin was 11 Gm. There was slight hypo-

chromia, anisocytosis and poikilocytosis. The red blood count was 3,420,000. The total white blood counts on graph showed a marked shift to the left. Kahn and Wassermann tests were negative, icteric index was 55 units, and the non-protein nitrogen was 32.4 mg. per cent.

The patient was prepared for surgery by intravenous administration of glucose, vitamin K, the oral administration of bile salts and a high carbohydrate diet. He was operated upon November 19, 1941, with a preoperative diagnosis of subacute cholecystitis, cholangitis and common duct obstruction with multiple liver abscesses.

Under local anesthesia the abdomen was entered through a high, right rectus incision. The gallbladder was delivered into the wound and found to be enlarged and very firm. There were plastic adhesions from the lower portion of the gallbladder to the neighboring duodenum and falciform ligament fat. The gallbladder was aspirated. It contained very dark bile. The lower portion of the bile of the gallbladder was very flocculant and semisolid in consistency. Numerous large, faceted stones were removed from the cystic duct where they had been impacted. The common duct was palpated and no stones or other pathological process was found. No other stones could be palpated. A large catheter was anchored into the gallbladder down to the cystic duct and irrigated with saline. Bile began to flow freely from the cholecystotomy tube. There were numerous small nodules in the liver substance that could be palpated. One of these was aspirated with a needle and contained pus, of which a culture was made. The cholecystotomy tube was brought out through a stab wound to the right of the incision. Due to the patient's condition no further surgery was attempted. The abdomen was closed in layers.

The postoperative diagnosis was subacute cholecystitis, cholelithiasis, common duct obstruction (due to edema of duct) and multiple liver abscesses.

The submitted tissue showed chronic cholecystitis with cholelithiasis and the culture from the aspirated liver abscess revealed *Bacillus pyocyanus*. (Fig. 1.)

The postoperative course was uneventful. After the second postoperative day the patient's temperature stayed normal. From the fourth to the twelfth postoperative day he drained profuse green pus. Bile drained well

from the cholecystotomy tube from the day of operation and it was removed on the twelfth postoperative day when the icteric index was

the newborn. Bacterolytic and leucocytic destroying ferments have been described by Wassermann and Gheorghiewski.<sup>18</sup>

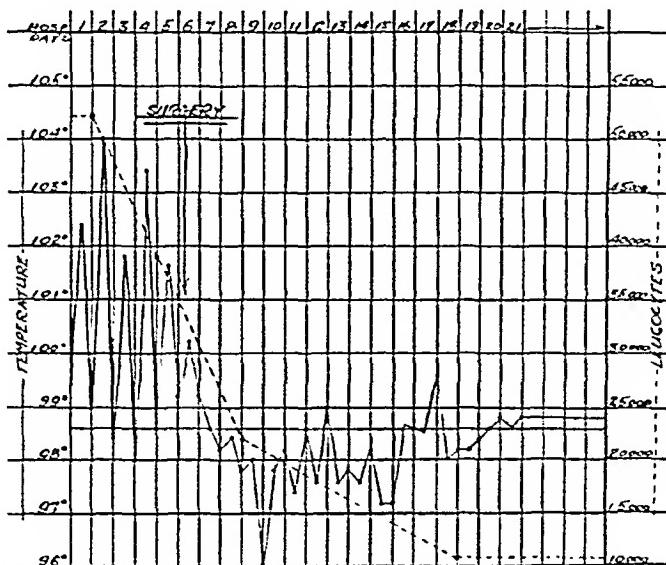


FIG. 1. Chart showing temperature and leucocyte count.

10.8 units. On the seventeenth postoperative day he was discharged in a wheelchair in a good condition.

He was seen again one month postoperatively and was in good enough condition to make the trip to his home seventy-five miles away. He was last seen three and one half months postoperatively and had no complaints. He had regained most of his strength.

#### BACTERIOLOGY

The *Bacillus pyocyaneus* as the cause of blue-green pus was first demonstrated by Gessary in 1882.<sup>18</sup> It is a short, gram-negative rod. It may resemble the diphtheria bacillus because of granules it sometimes contains. It is an aerobe and a facultative anaerobe. However, it does not develop its characteristic pigmentation under anaerobic conditions. Hence, in our case the aspirated pus from the liver was milky color and the drainage brilliant green.

The *Bacillus pyocyaneus* is one of the less virulent pathogenic bacteria. However, cases of death due to infection with it have been reported. It is a frequent cause of epidemic umbilical infection in

#### CONCLUSION

We believe this to be the first proven case of multiple liver abscesses due to *Bacillus pyocyaneus*, from which the organisms were cultured from the liver abscess, to progress to complete recovery. A brief outline of our method of treatment is given as well as a summary of the pertinent literature on the subject of multiple pyogenic liver abscesses.

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If Volkmann's ischemic contracture occurs it should be recognized in its early form and treated immediately by incising the fascia of the forearm in order to evacuate the underlying hematoma. Special splints should be fitted for gradual correction and stretching of contractures. In most instances radical operations are eventually necessary.

# PRIMARY BRONCHOGENIC CARCINOMA\*

## REPORT OF A CASE

CAPTAIN CLARENCE C. HETZEL, JR., M.C. AND FIRST LIEUT. JAMES H. WALKER, M.C.  
MCCHORD FIELD, WASHINGTON

THIS case of pulmonary carcinoma is reported for the following three reasons: (1) It illustrates the point that malignant tumors will be found in army hospitals because of the overlapping of the age of malignancy and the draft age limit; (2) it illustrates the adequate work-up that a patient can receive on entering an army hospital; and (3) this case presents several features not commonly seen as such in primary bronchogenic carcinoma.

### CASE REPORT

No 4798, a forty-year old white male, was admitted to the McChord Field Station Hospital with complaint of pain in his right chest. The family history was noncontributory. His past history revealed that the patient had an urethritis in 1937, an appendectomy and tonsillectomy in 1939, had worked in a state mental institution during the past year and was associated with tuberculous patients, and that he had been under the care of his private physician for an infarct of the right lung and possible tuberculosis.

The onset of the present illness dates back to 1937 with symptoms of pain in the right side of the chest and hemoptysis. In 1938, the patient was in a southern hospital twice because of these symptoms. He was bronchoscoped and had a bronchogram. Since no treatment was recommended, it is assumed that the examinations at that time were negative. The hemoptysis often came on suddenly and without warning, although it did seem to occur more often while exercising. At times the patient had a feeling of warmth in his chest and then he would cough blood. The hemoptysis was pure blood; at first it would be as much as one-half a cupful and during the next ten to fifteen days it would gradually decrease in amount and finally disappear for one to four weeks. There was

always a dull nonradiating pain in the right chest, along the anterior costal margin and extending into the right axilla. During periods of active bleeding the pain would become sharp in character. The past four years the pain and hemoptysis have gradually become slightly worse. On admission the patient stated that he had not coughed blood for two weeks. He felt feverish and had a slight nonproductive cough. He had no symptoms of bronchial obstruction such as wheezing, dyspnea, or coughing foul-smelling sputum. There have been only about ten pounds of weight loss in the past four years. A review of the systems was otherwise noncontributory.

His temperature was 102.6°F., pulse 84, respirations 20, blood pressure 128/78, weight 136 pounds, height 66 inches.

A fairly well developed and well nourished dark-skinned male who did not appear very ill was admitted to the hospital. The patient had a moderate degree of scoliosis. The examination of the head and neck was negative. The patient indicated pain along the anterior costal margin which extended superiorly to the sixth interspace in the midclavicular line and laterally into the right axilla. There were a few moist râles heard in the right interscapular area of the chest, otherwise it was clear. The abdomen protruded moderately and a well healed lower right rectus scar was present. Rectal, neurological, bone and joint examinations were also negative.

Sputum examinations were negative for tuberculous bacilli, but always positive for blood. The tuberculin was negative to 1:1000 dilution after forty-eight hours. Gastric washings were negative for tuberculous bacilli. Sedimentation rates: 70, 46, 48, 48. Red blood cells numbered 4,484,000; hemoglobin 95; white blood cells 8,400; polymorphonuclears 70; lymphocytes 28, and monocytes 2. This count remained essentially the same during his hospital stay. Kahn and Wassermann tests

\* From the Surgical and Medical Services, Station Hospital, McChord Field, Washington, Major Donald E. Reiner, Surgeon.

were negative, and the urinalysis was also negative.

X-rays revealed a mass of homogeneous



FIG. 1. X-ray showing the mass extending out from the right hilar region at the seventh interspace.

density, extending from the right hilar region at the seventh interspace about  $1\frac{1}{2}$  inches in diameter and of smooth outline. The mass did not cause any esophageal defect after a barium meal. A bronchogram revealed a slight puddling of the lipiodol just above the bronchus to the right middle lobe. Pyelograms and gastrointestinal studies were negative.

The patient's temperature returned to normal his second day in the hospital and remained within normal range during his stay in the hospital. On the second day he suddenly coughed about one-half a cupful of pure blood. During the next ten days this gradually decreased in amount so that on his twelfth hospital day he did not cough any blood. The bronchoscopist examined the patient, and his note is as follows: "Bronchoscopy revealed a smooth, rounded tumor mass just at the middle lobe bronchus which has no abraded surface, but began to bleed much and ooze up from the periphery and obscure a good view of the tumor. The carina was normally thin, moved normally with respirations and heart beat. No metastatic areas visible. I believe this is a benign tumor of the right main bronchus just proximal to the

middle lobe bronchus on the medial wall." (C. C. Hetzel, Jr. Captain, M.C.) The consensus of opinion among the pathologists on the biopsy specimen obtained at bronchoscopy was a primary bronchogenic carcinoma, and probably of the small round cell type.

#### REMARKS

The differential diagnosis involved in this case was between tuberculosis, a benign pulmonary tumor, and a primary malignant pulmonary tumor. Tuberculosis was ruled out by the absence of tuberculous bacilli in sputa and gastric washing examinations, negative tuberculin tests, and the x-ray picture was not indicative of tuberculosis. A diagnosis of a benign pulmonary tumor was made on the long duration of symptoms (four to five years) and their appearance before the age of forty, a loss of weight of only ten pounds in four years, and frank hemoptysis being one of the first symptoms to appear.<sup>1,2,4</sup> In addition to these points the bronchoscopic picture was that of a benign tumor.<sup>1</sup> Thus, when the biopsy report of a malignant pulmonary tumor was returned, the patient was re-examined carefully and laboratory data reviewed in order to rule out the possibility of the lesion's being a metastatic tumor. With such evidence as the only symptoms being pulmonary ones and the absence of positive findings in the rest of the body, the final impression at this hospital is that of a primary bronchogenic carcinoma.

Since this case presented several unusual clinical features, it was decided to report these, which are: (1) The long duration of symptoms (four to five years); (2) pain and frank hemoptysis were the earliest symptoms, instead of late as is the rule; (3) a loss of weight of only ten pounds in four years; and (4) the bronchoscopic picture was that of a benign tumor.

This patient was transferred to a large army general hospital for surgical treatment. "Patients with suspected or proved primary carcinoma of the lung are surgical problems until proved otherwise."<sup>3</sup>

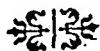
## CONCLUSIONS

1. A case of primary bronchogenic carcinoma is presented.
2. Symptoms appeared early which are not usually seen until late in the course of the malignancy.
3. This case illustrates the thorough examination a patient may receive in a small army station hospital.
4. Malignancy will be found in members

of the United States Army because of the overlapping of the draft age limit and the age at which malignant tumors are found.

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FRACTURES of the leg are accompanied by shock and cause extreme pain. With linear fractures the only signs may be swelling, ecchymosis and tenderness. With displacement the diagnosis is plainly evident by deformity, shortening, abnormal mobility, and crepitus.

The brief excerpts in this issue have been taken from "Fractures and Dislocations for Practitioners" by Edwin O. Geckeler (The Williams & Wilkins Company).

# Bookshelf Browsing

## THE DOCTOR, MEDICAL SCIENCE AND THE CLINIC\*

CHAS. GORDON HEYD, M.D.

Professor of Surgery, New York Post-Graduate Medical School and Hospital

NEW YORK, NEW YORK

OUR country is at war and drastic changes have taken place in pre-medical and medical education. As a defense measure the government has introduced a new concept of medical education. After three years of an accelerated medical course the doctor will be permitted nine months in a hospital for a general rotating internship. His training under the accelerated plan has been continuous and progressive and some of the usual auxiliary features of a medical course have been abridged and many sharply curtailed. The graduation of a young doctor today is held under the shadow and repercussions of the world catastrophe of war. However, we may take renewed inspiration and new faith that no matter how difficult the road and how beset with trials and tribulations the medical profession shall not be wanting in co-operation or in that loyalty that it has so eminently donated throughout history.

New conditions demand new technics, but great moments in history have much in common. In 1861, our country was engaged in a gigantic fratricidal war to determine whether this union of the United States was to survive. The occasion was an address to the medical class at Harvard, on November 22, 1861, the speaker Oliver Wendell Holmes, Parkman Professor of anatomy and physiology. After eighty-two years Dr. Holmes could repeat: "The young man who has not heard the clarion voices of honor and of duty now sounding throughout the land will heed no word of mine. In the camp or the city, in the field

or the hospital, under sheltering roof or half protecting canvas or open sky, shedding our own blood or stanching that of our wounded defenders, students or teachers—whatever our calling and our ability, we belong, not to ourselves, but to our imperiled country, whose danger is our calamity, whose ruin would be our enslavement, whose rescue shall be our earthly salvation. . . . You cannot all follow the armies of your country to the field. But remember that he who labors for the general good at home is an ununiformed soldier in the same holy cause with those who bear arms or minister at the side of the ambulance and in the camp hospital. Larrey claimed no precedence of Dupuytren, nor Guthrie of Sir Astley Cooper."

Society is composed of individuals and responds to evolutionary impulses in a manner similar to that of the organic world. Mere change is not necessarily progress. The medical undergraduate days, such as the writer knew, are changed and gone forever. Certainly the vista of the future is markedly different from that in June, 1909. The author is firmly convinced, however, that medical knowledge must be digested and that rest must precede and follow intense intellectual activity. During a student's medical course he receives an immense amount of instruction. The possession of medical knowledge is essential to his vocation. The rational organization of clinical and laboratory experience is the basis of his professional career. As time goes by, it becomes more evident

\* Commencement address, Medical Department, University of Buffalo, March 24, 1943.

that in preparing to be a doctor he was dedicating himself to a life of scholarship. New medical alignments must be made from time to time. In general, his future education will be due to personally enforced discipline. There is in his case, first the professional or vocational education, and secondly the liberal education that concerns itself with the broad cultural background of mankind and its relation to the social order in which he is to live, to earn his livelihood and to function as a doctor. Doctors are the medical descendants of Ambroise Pare, John Hunter, Lister and Osler, as much as the product of the faculty. Their medical education up to graduation has provided only an introduction and a background.

The following is an example from the author's own experience: In June, 1909, a graduating class occupied the orchestra in the Teck Theater. After receiving his degree the doctor went his separate way. A period or epoch in his life was terminated. Yet all of us were committed to a medical career. We could not determine our professional environment but we could decide how we would react to that environment. Little did we realize what splendid discoveries in medicine were before us. In 1905, Schaudinn discovered the Treponema pallidum and the entire pathogenesis of syphilis was rewritten. Within a year Wassermann introduced his serum-diagnosis and in 1910 Ehrlich and Hata discovered salvarsan. Within the space of five years we were to witness the epoch making elucidation of a disease that wrecked human beings from the cradle to the grave and even unto the third and fourth generation. Looking forward Cushing was to describe dyspituitarism and Peyton Rous transmit sarcoma by a filterable virus, while at the same time Great Britain adopted compulsory Health Insurance. We were to learn that emetine was a specific for amebic dysentery and Shick was to demonstrate the susceptibility test for diphtheria. Morphine-scopolamine narcosis, under the euphemism of twilight sleep, was to bloom

and fade. Aschoff was to elaborate the reticuloendothelial system, and Holst and Frolich postulate vitamin c; the Coolidge tube and the Potter-Bucky diaphragm were to enlarge the domain of roentgenology. During World War I, Kendall was to discover thyroxin, Goldberger to envisage the cause of pellagra and Wagner von Jauregg treat paresis by superinfection with malarial fever. The sedimentation test was on the way, and Rubins was to insufflate fallopian tubes for sterility. In 1921, Banting and Best isolated insulin and diabetes mellitus was to have a definite therapeutic remedy; the examination of the hollow viscera—cholecystography, ventriculography and urography—were to become important diagnostic aids while Minot and Murphy were to re-examine pernicious anemia and introduce raw liver diet. Collip was to isolate parathyroid hormone and its relation to calcium metabolism; and as a result tetany and certain bone conditions were to have a new interpretation and therapy. Shock and the treatment of burns were to have a rational explanation; blood banks and plasma therapy were established; biochemical deficiencies claimed a place in therapeutics, and the detection and clinical effects of the loss of water, electrolytes and plasma protein were to be developed. The mysterious and romantic subjects of the vitamins and endocrine that now adorn textbooks were to be crowned by the discovery and clinical application of the "sulfa" drugs. This recital of achievements in medical science since I was graduated, brief, as it necessarily must be, serves only to emphasize that medicine is an advancing science and demands continuous study and application.

On the other hand, the diseases we now know least about are high on the list of frequency, danger and disability. Cancer, hypertension, nephritis, cardiovascular disease and arthritis are at the present time our most dangerous in terms of mortality and morbidity. The commencement day orator thirty four years hence will no

doubt indicate to the graduating class of that day, the causal factor in arteriosclerosis, hypertension and arthritis. He perhaps will have much to say about the etiology of coronary thrombosis, cardiovascular disease and nephritis. He will consider if not explain the transformation of a disease entity into another type of malady, the refractory anemias and their analogue leukemia, the rôle of amino acids in human nutrition. He may review the specific isolation and therapy of the virus diseases. He will explain the cancer-producing substances that are known now to be present in vitamins, hormones and estrogens, as well as, in the coal tar product, anthracene. He may predicate or announce the etiology of cancer by discussing the peculiarities of biotin and its carcinogenic properties in relation to the vitamin B complex and a possible chemotherapeutic cure of cancer. The future expansion of chemotherapy will be noted and anticipated by the discovery of new chemical agents with clinical applications now so familiar in the sulfa drugs. There might well be a note of sadness when the future class day speaker looks back upon the social callousness of 1942 that accepted, without indignation, 93,000 deaths from accidents, of which 47,500 were workmen killed on or off the job.

It would appear that the doctor today must be a combination of a physiochemist and a laboratory technician. A short time ago the biochemical department at the Post-Graduate Hospital sent to the staff a short memo listing fourteen "new" tests for liver function—a Pandora's box of chemical gifts. I am not affected with kainophobia—a fear of new things—but frankly I sometimes wonder if we are not exalting science at the cost of personal clinical capacity. My medical school days were spent in the brilliant twilight of the heroic age of medicine, the period of great clinicians with their splendid professional and cultural attainments. It was a period of close and friendly association, in the school, the clinic and in the wards. By per-

sonal contacts with the Masters we became recipients of their experience. We learned much of their medical intuition and clinical acumen. These are the clinical qualities of head, heart and hand that Stephen Paget in his delightful biography ascribed to Ambroise Paré. "Truly his theories and explanations are childish, and his ignorance of things not yet discovered is as profound as our own but put Ambroise on one side of the patient's bed, and a surgeon of our day, singlehanded on the other, and you will not find the balance of insight and practicality against Ambroise."

It would be interesting if one had the power of divination to cast another's horoscope, "to look into the seeds of time and say which grain will grow and which will not." However, it is possible to preview a young doctor's position in a wartime society as well as his prospective place in the postwar re-alignments of medical practice. The exigencies of war will limit his hospital experience to nine months after which time he becomes, automatically—if physically fit—a medical officer with the armed forces. His future, therefore, will be divided into three periods—unequal and wholly different—first the internship, secondly the war service and finally the post-war career. The nine months' internship is a war limitation, but it will start the young doctor's hospital training under the proper auspices. Furthermore, it will be the starting point for a real internship and residency when he is returned to civil life. It should be the duty of the medical schools and hospitals to assure all their staff officers, interns or residents, that their place, insofar as human predication can go, will be returned to them after the war. During the doctor's war service he will be able to appraise his talents better than today. Some will probably remain in active service—an honorable career offering great opportunities for distinction. Perhaps many have seen the series of paintings by Dean Cornwell entitled "Pioneers of American Medicine."\* In two of the four

\*John Wyeth and Brother, Inc., Philadelphia, Pa.

portraits the chief personage depicted wears an army uniform—Beaumont and Walter Reed. The talents of Paré, Hunter and Pirogoff differ only in their activation from those of Russell, Gorgas or Leonard Wood. The global war is advancing the frontiers of epidemiology and preventive medicine. World-wide malaria with new strains of the plasmodium and with new vectors, endemic plague in the coastal towns of North Africa, epidemic typhus and a new genera of hostile dysentery organisms now confront us. The war trained physician will be our main defense against these pathogenic armies of invasion. The Army trained doctor will become the leader in an expanding science of preventive medicine. The teaching of these army doctors in the postwar period will be a centrifugal force, spreading from our hospitals and medical schools to an enlarging sphere of usefulness. In addition the doctor with the armed forces will have a valuable experience in the psychology and character of men under the stress of unusual circumstances. It may also, if destiny is on his side, favor him with an exceptional training in one of the major subdivisions of medical practice. It is an interesting fact that about 20 per cent of the physicians listed in the Directory of the A.M.A. are full time specialists. Whereas over 70 per cent of the interns in the hospitals approved by the Council on Medical education and hospitals, have indicated their desire to qualify for one or other of the fifteen Specialty Boards. If we may judge the future by our experience in the past, we can foresee a definite trend toward post-war specialism and a remarkable acceleration in the resident system.

For example, in 1930, 338 hospitals had some 2,000 resident positions. In 1931, 518 hospitals had 4,556 residencies. Again, in 1934, there were 332 three-year residencies in approved hospitals. These 332 three-year residencies had increased to 1,791 by 1939, an increase in approved residencies of over 100 per cent per year. It should be understood clearly that a residency pre-

supposes a period of training under direct teaching supervision and not just contact with patients. The residency should supply adequate clinical material for diagnosis and treatment, and at least one-sixth of the total period should be spent in the laboratory. There must be sufficient clinical opportunities for a thorough mastery of all the technical procedures in the operative specialties.

The primary function of a hospital is not that of a well managed hotel for sick people but that of a temple of medical science. Within the hospital the resident will acquire much additional training under supervision with added experience in diagnosis, treatment and clinical responsibility. Great as these increments to medical knowledge may be, they are not by themselves sufficient. Only from teaching or from association with a teaching group will the young doctor receive the stimulus so necessary for the full development of his talents. Allied to a teaching responsibility is the energizing effect of an independent adventure in either clinical or laboratory research. He need not be born a laboratory man in order to be identified with worth while research. The search for truth may be in the wards, the clinic, or in the amphitheater, as well as in the laboratory. Corrigan, Graves and Bright needed no laboratory to acquire medical immortality, while Lister could apply the laboratory discoveries of Pasteur, a chemist, to found modern surgery.

Some there are with sensitive imaginations who are "laboratory born" and who will be happy only in the pursuit of science. There may be one doctor with the divine vision to see through the fog of ignorance and with a flash of intuitive genius bring forth a scientific discovery that may be applied by others to the alleviation of suffering or cure, if not the banishment of some disease. However, it is significant that the science of Harvey, Hunter, Jenner, Koch, Lister and Banting was in no way imperiled because they were practitioners. In all probability a physician's investiga-

tive curiosity will not be productive research. That does not matter. He can, however, interest himself in the less common, or the obscure and unknown and thereby develop the joyful habit of continuously adding to his store of personally acquired medical knowledge. With less opportunity than now lies before the young doctor today, Paré could say: "See, how I learned to treat wounds made by gunshot, not out of books."

Medicine had its origin in service. It has maintained itself by adopting the discoveries in pure science. Its password should be competency; competency comes only with application and training. To know the trade name and dosage of one of the sulfa drugs is not a knowledge of pneumonia and "to dust" sodium sulfathiazole in an infected peritoneal cavity is not a training in the physiology, pathology or technology of abdominal surgery.

Medicine is not an isolated activity of society. It has no separate identity by and for itself. On the contrary, it is an integral part of the collective efforts of society. It is universal and ministers to all regardless of race or color or creed. Every doctor may say: "I am a man and nothing human is alien to me."

Stephen Paget draws attention to the creative function of the doctor. For example, let us consider an attending surgeon in charge of forty hospital beds. Allow him six weeks' holiday and put the average stay of his patients in the hospital at three weeks. That gives him 300 patients a year. Take any ten of these patients. Of the ten let us assume that one dies, one is none the better for treatment and three being cured of maladies which could not shorten life, gain nothing in length of days. That leaves five patients; of these five, let us guess that two gain five years, two gain ten years and one gains thirty years of life. That gives a gain of sixty years in ten cases, or 1,800 years on 300 cases. In twenty years, at that rate, the surgeon will have saved 1800 times 20, or 36,000 years of other peoples' lives. Of course, he can-

not alone claim these extended years; many minds, hearts and hands are at work with him. Still, the years are saved.

In youth one is inclined to believe that life is a straight line; it is only a straight line when viewed in distant objectivity. It consists in the main of a series of hills and valleys, and only the mean trajectory is straight. There is in every life the effort, knowing or unknowing, to obtain a balance between the inner life and its external expression—a balance of work, of love, of play and of prayer. I know three "oldsters" now living beyond the biblical three score and ten—one in Buffalo and two in my own community. In their younger days they helped to weave the tapestry of medicine with all its splendid colors. If they had taken only a narrow professional view of life, their later days would be barren of the joy that comes to a fruitful and contemplative mind. They have as their reward the satisfaction that they once labored in the Master's vineyard. They now participate in the pageant of medical progress and review their youth at the meetings of the various medical societies and in the companionship of their junior colleagues. Their life represents a correct balance and they approach retirement as one who

"Shall come to his grave in a full age,  
Like as a shock of corn cometh in,  
in his season."

If a physician's gaze is always fixed on his medical activities or if the focus of his viewpoint is its monetary reward, his vision will be truly myopic and he will miss the real significance of medicine as a way of life, as a balance of essentials. The physician should have a due and proper regard for the value of his services when expended upon those able to pay. It has been my experience that the remuneration from the practice of medicine is ordinarily quite sufficient for a reasonably comfortable life. You can never hope to be rich in the terms of the financial world from the practice of medicine. But I believe a doctor

will always have a sufficiency irrespective of the medical system under which he may practice. I cannot tell the name of any doctor, except for reasons of health, who gave an adequate medical service and suffered from a grave insufficiency of living income. However, I can name many physicians who embarked on an alien career of high finance called the "stock market" and who hoped to enrich themselves without labor and almost inevitably the end was disaster.

No one is complete unto himself. To be sociable with one's colleagues and competitors is to follow the tide of medical progress. In the society of his equals a young physician will derive the most pleasure but it is from men with superior talents that he will learn the most and have the greatest incentive to work and to develop himself. A valuable asset in his life is membership in his County and State Medical Societies as well as the American Medical Association. There is a tendency for the physician to lose touch with his medical society and to forego their meetings. These are the medical fora of his craft. It is only there that he will extend his experience and keep medically young by contact with youth. There he will learn of recent research and the contributions of his colleagues. From them he will receive the stimulus for further study. Their meetings will provide an intellectual domain where bright mind answers mind.

A young physician should cultivate his medical library and by familiarity learn how to utilize medical literature. By slow degrees and painful effort, by trial and failure he should acquire an ability to write easily and clearly. Writing even for an alert mind and facile pen require labor and training.

"Reading maketh a full man, conference a ready man and writing an exact man."

Remember that St. Luke was a physician and the best of the Gospels came from his pen.

Habits of scholarship when once attained will fill a doctor's life with interest.

My personal inclination has been for biography; to read what other men, in other times, have made of their lives, how they have affected their environment or been molded by it, how in contributory service they have reached beyond their life age and influenced my life, as well as the lives of others. Medical biography is of outstanding importance in showing the development of medicine as well as society. To be familiar with the great medical men of the past is to understand the real significance of practice. To look at the second hand of one's watch is to recall Dr. John Floyer, the inventor, and meet his patient, Samuel Johnson; to cleanse one's hands surgically, is to see the pathetic figure of Semmelweis and realize the horrors of puerperal sepsis; to know Dr. Ephriam McDowell and Jane Todd Crawford, his patient, is to be present at the first ovariotomy in modern gynecology; and to study the career of Pasteur is to become acquainted with "the most perfect man who has ever entered the Kingdom of Science."

By daily study the mind can be developed into a trained mechanism. Any study will suffice if carried out day after day. The time spent at it need not be long. It is the daily repetitive application that trains the mind in concentration and memory. There is no better exercise than the acquisition of a reading and speaking knowledge of a foreign language. The acquiring of a second speech is an excellent method for cultural expansion. That is the real objective of education. It is a discipline, acquired by labor and the expenditure of time. It is, however, an end in itself, for mental discipline is based primarily on self-interest. Yesterday is past, and tomorrow is uncertain, but

"What each day needs that shalt thou ask  
Each day will set its proper task."

A physician should be proud of his profession. It is an honorable calling, and one of the great intellectual disciplines. It has existed since the early days of man and has an authentic history, beginning four

hundred years before the Christian era. It has suffered much from war, revolution and politics, but, it has survived as an organized guild devoted to suffering humanity. Whether it is a profession or a trade it will survive as an organized unit of society. Always there is the individual doctor, and the individual patient—at birth, at illness and at death; and as that individual doctor advances with training and experience he will have greater and greater opportunities to minister to the welfare of mankind. The practice of medicine is a ministry.

"Blessed is he who carries within himself a God, an ideal, and who obeys it. Ideal of Art, Ideal of Science, Ideal of Country, Ideal of the Gospel Virtues. Therein lie the springs of great thoughts and great actions."

A recent social document (Beveridge) of world wide interest states: "In the presence of revolution we may require revolutionary solutions and not just a patching of our social structures." The social objective of a security and protection from the cradle to the grave will eventually be an economic and biological failure. The history of anthropology reveals no single instance of survival when the organism singly or as an individual member of a gregarious unit, failed to energize itself by personal effort in order to maintain and reproduce himself. If man is to survive as an individual social unit, free from the concentration camp of political slavery he must return to the ancient philosophy of the old Testament, "In the sweat of thy face shalt thou eat bread." This divine injunction was not given unto man as punishment but as a way of life, a rational program for happiness. Only those who work merit "A happy life and a happy calling." For centuries medical practice was in chains, enslaved by a rigid formalism which cared

more for doctrine than for investigation. Great names dominated medical thought for centuries. Only with the emergence of the universal mind of a Leonardo did medicine become free and begin its remarkable progress. It would appear that the world at the present time is moving to the left. Today emphasis is placed upon quantity not quality. Research is ordered to pattern, while our cities grow larger and larger, and individuals live in more and more congested dwellings and "with the development of urban civilization and industry, physical deterioration becomes appallingly common and every sort of physical abnormality is increasingly prevalent."

Socialization of medicine is preached as part of a new Utopia with a vast bureaucracy (of mediocrity) for its administration. When the political state destroys the freedom of choice for a career, at that precise moment genius and initiative are also destroyed.

"Between two worlds, one dead,  
The other powerless to be born."

A young physician looks out on a vast social revolution, global in range and viewpoint but national in application. Medical practice for better or for worse will change under the impact of revolutionary forces. He may be called upon to advise and treat the socio-political ills of his society in no less degree than in maintaining his own personal professional status.

Fear not! life still  
Leaves human effort scope  
But, since life teems with ill,  
Nurse no extravagant hope;  
Because thou must not dream,  
thou needst not then despair.\*

\* Empedocles on Etna—Matthew Arnold.



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